Urban Resilience and Sustainability Challenges: A Case Study on the City of Windhoek

by

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Declaration

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Abstract

The concept of sustainable development resulted after a global connection in environmental problems was found. *Our Common Future*, also known as the Brundtland Report, provided a strategic foundation to among others, the 1992 Earth Summit in Rio de Janeiro which led to the UNCED framework known as Agenda 21. Many countries are affected by climate change and sustainable development is being introduced into policy documents. Resilience is increasingly used in sustainable development policies, climate change adaptation and disaster risk reduction.

Urbanisation has occurred at a rapid pace in Namibia and many people from rural areas have migrated to Windhoek in search of better employment and an improved quality of life. The urbanisation has led to various sustainability challenges in the ecological-, social-, housing- and political environment.

This study describes the sustainability challenges in Windhoek, the capital city of Namibia. Shortly after Namibia's independence in 1990, various environmental policies and development plans were put in place to guide environmental management in Namibia. These environmental policies and development plans of Namibia are reviewed to determine whether they are adequate for addressing sustainability challenges in Windhoek and to strengthen resilience in the City of Windhoek. The study concludes with recommendations on improving the sustainability of, and urban resilience for, the City of Windhoek.

Lessons are also drawn from the sustainability success stories of the City of Seattle in the USA, Curitiba in Brazil and Bogotá in Colombia and for recommendations to assist the City of Windhoek in its journey towards sustainability and improved resilience.

The study's findings suggest that sustainability forms part of the environmental legislation; however, the implementation has not been effective, such as in the case of the City of Windhoek. Resilience only surfaced in the latest development plan on Namibia.

Opsomming

Die konsep van volhoubare ontwikkeling het ontstaan nadat omgewingsprobleme globaal saamgevoeg is. *Our Common Future*, ook bekend as die Brundtland-verslag, het ’n strategiese basis verskaf aan onder meer die Aarde Spitsberaad in Rio de Janeiro, wat in 1992 plaasgevind het, en wat tot die UNCED-raamwerk, bekend as Agenda 21, aanleiding gegee het. Talle lande word deur klimaatsverandering geraak en volhoubare ontwikkeling word al hoe meer deel van beleidsdokumente. Lewenskragtigheid word toenemend in beleide oor volhoubare ontwikkeling, aanpassing in klimaatsverandering en vermindering van ramprisiko gebruik.

Verstedeliking het teen ’n snelle tempo in Namibië voorgekom en mense uit plattelandse gebiede het na Windhoek migreer op soek na beter indiensneming en ’n beter gehalte van lewe. Dié verstedeliking het aanleiding gegee tot verskeie volhoubaarheidsuitdagings wat betref ekologiese, sosiale, behuisings en politieke aangeleenthede.

Hierdie studie beskryf die volhoubaarheidsuitdagings in Windhoek, die hoofstad van Namibië. Kort na Namibië se onafhanklikheidswording in 1990, is verskeie omgewingsbeleide en ontwikkelingsplanne in plek geplaas om leiding te bied wat omgewingsbestuur in Namibië betref. Hierdie omgewingsbeleide en ontwikkelingsplanne van Namibië word hersien om vas te stel of hulle bruikbaar is om volhoubaarheidstudies in Windhoek aan te spreek en lewenskragtigheid in die Stad Windhoek te verstewig. Die studie sluit af met aanbevelings vir die verbetering van die volhoubaarheid en stedelike lewenskragtigheid van die Stad Windhoek.

Lesse geleer van volhoubare suksesverhale van die Stad Seattle in die VSA, Curitiba in Brasilië en Bogotá in Kolombië word gebruik om verskeie aanbevelings te doen om the Stad Windhoek by te staan met sy strewe na die bereiking van volhoubaarheid en verbetering van lewensvatbaarheid. Die studie se bevinding dui daarop dat volhoubaarheid deel uitmaak van die omgewingswetgewing, maar die implementering het getoon nie so doeltreffend te wees soos in die geval van die Stad Windhoek nie, waar verskeie volhoubaarheidsprobleme steeds aanwesig is. Lewenskragtigheid het

eers in die jongste ontwikkelingsplan met betrekking tot Namibië deurgeskemer en het nie voorheen deel van omgewingswetgewing uitgemaak nie.

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List of Acronyms and Abbreviations

AFSUN	African Food Security Urban Network
BEQUEST	Built Environment Quality Evaluation for Sustainability through the Time
BON	Bank of Namibia
BRT	Bus Rapid Transit
CALFED	California's program for water management
CAS	Complex adaptive system
CBO	Community Based Organisation
CEO	Chief Executive Officer
CSR	Corporate Social Responsibility
DEA	Directorate of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DTA	Democratic Turnhalle Alliance
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
GCM	Global Circulation Models
GIS	Geographic Information System
GIZ	Deutche Gesellschaft für Internationale Zusammenarbeit
GRN	Government of Namibia
HPP	Harambee Prosperity Plan
IEA	Integrated Environmental Assessment
ICN	Initial National Communication
IEM	Integrated Environmental Management
IPCC	Intergovernmental Panel on Climate Change
IPPUC	Institute of Research and Urban Planning in Curitiba
OECD	Organisation for Economic Co-operations and Development
PDM	Popular Democratic Movement
MA	The Millennium Ecosystem Assessment
MDG	Millennium Development Goals
MDGR	Millennium Development Goals Report
MET	Ministry of Environment and Tourism

MRF	Material Recover Facility
NABTA	Namibian Bus and Taxi Organisation
NBSAP	National Biodiversity Strategy and Action Plan
NCCSAP	National Climate Change Strategy and Action Plan
NDP	National Development Plans
NGO	Non-Governmental Organisation
NHAG	National Housing Action Group
NMT	Non-Motorised Transport
NPPTA	Namibia Public Passenger Transport Association
NTTU	Namibia Transport and Taxi Union
NUDO	National Unity Democratic Organisation
NUST	Namibian University of Science and Technology
RDP	Rally of Democracy and Progress
SADC	Southern African Development Community
SD	Sustainable Development
SDAC	Sustainable Development Advisory Council
SDF	Spatial Development Framework
SDFN	Shack Dwellers Federation of Namibia
SEA	Strategic Environmental Assessment
SES	Socio-Ecological System
SOER	State of the Environment Report
U.S	United States
SUTMP	Sustainable Urban Transport Master Plan
SWAPO	South West African People's Organisation
TBL	triple bottom line
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNISDR	United Nations International Strategy for Disaster reduction
UNAM	University of Namibia
USA	United States of America
VAT	Value-Added Tax

WESP	Windhoek Environmental Structure Plan
WCED	World Commission on Environment and Development
W-MARS	Windhoek Managed Aquifer Recharge Scheme
WSSD	World Summit on Sustainable Development
WTP	Willingness to Pay

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CHAPTER 1 – INTRODUCTION

1.1 Background

In the TV programme, Carte Blanche on 17 January 2016 there was a documentary concerning the El Niño weather factor and how climate change is worsening its effects on the environment. In it Dr Stephen O'Brien, the United Nations Emergency Relief Coordinator, was interviewed. He indicated that the effects of El Niño are felt across the world and that the present one is the most powerful yet. He went on to say that El Niño tests our commitment to early action. What interested me most about what he said was the question he posed: "The warning signs are there, are we prepared to act on them?" In the same documentary, Professor Bruce Hewitson, Director of the Climate Change and System Analysis Group at the University of Cape Town, said that additional climate stresses are pushing cities towards their thresholds of sustainability, and once these thresholds are crossed, the systems will collapse. He emphasised that it is important for cities to put in place various measures to build resilience (Carte Blanche, 2016). This documentary was a wake up call and made me think to myself, "Is Windhoek a resilient city that will be able to adapt to the unreliable environment, and is the city developing sustainably to minimise further negative impacts on the environment that contribute to climate change?"

Increasing levels of urbanisation around the world see people moving from rural areas to cities for job opportunities with the hope of improving their quality of life (Fox, 2012: 303-304; Chen *et al.*, 2014: 11). Similarly, after independence in 1990, Windhoek, as the capital city of Namibia, has experienced rapid urbanisation. This has led to various sustainability challenges in Windhoek, which will be discussed later in this study.

This study proposes to explore Windhoek's sustainability and approach towards resilience through a literature review and review of legislation. The sustainability challenges in Windhoek will be briefly outlined.

1.2 Problem statement

Hopwood, Mellor and O'Brien (2005: 39) explain that the notion of sustainable development (SD) followed linking of environmental problems worldwide. The 1972 Stockholm Conference on the Environment and Development and "Our Common Future", commonly known as the Brundtland Report (Hattingh, 2001: 4-5), laid the strategic basis for *inter alia*, the 1992 Earth Summit in Rio, the World Summit on Sustainable Development (WSSD) and various other policy conferences between 1972 and 2002 (Swilling & Annecke, 2012: 26). Cities worldwide are affected by climate change and the outcome of these conferences has resulted in sustainable development being introduced into policies worldwide. Namibia has been aligning its policies to the approach of sustainable development since the Rio Convention in 1992 and policies have been put in place accordingly to promote sustainability in the country.

Urbanisation in Namibia and Windhoek is occurring at a rapid pace (GRN, 2011b: 37-39), in an environmental context of unpredictable rainfall. According to Van Rensburg, (2006: 23) already in 1968, a Water Reclamation Plant was built in Windhoek to reclaim potable water directly from domestic sewerage. Windhoek has no perennial rivers running through it and relies on the annual rainfall to fill the three dams that supply water to it. Underground water is also limited and cannot supply the entire City with water during droughts. Moreover, many migrants settle in informal settlements, and the City finds it difficult to meet their basic needs. Therefore, many residents have inadequate access to essential services such as clean water, electricity and sanitation (City of Windhoek, 2011: 13-14). This leads to households depending on wood that they collect from trees as an energy source for cooking (Hasheela, 2009: 53-54).

It would therefore be of benefit to investigate how the City could adapt to environmental changes and continue on the path to sustainability through building its urban resilience.

1.3 Research aim and objectives

The research questions of the study are:

i) What are the current challenges that have an impact on sustainability in Windhoek?
ii) Are the current policies and plans adequate for addressing the sustainability challenges in Windhoek, and to build urban resilience?
iii) What mechanisms are required to address the challenges facing Windhoek with respect to urban resilience and sustainability?

The specific objectives of the study are to:

i) Identify and describe the environmental challenges for sustainable development in Windhoek by means of documentary research.
ii) Examine relevant policies and plans, and determine whether they are adequate for addressing sustainability challenges in Windhoek, as well as to build urban resilience.
iii) Based on the literature and data gathered from the review of policies and plans, make recommendations for addressing sustainability challenges and to build urban resilience.

1.4 Research methodology

The research design is that of a non-empirical study, through content analysis, where literature reviews on the themes of urban resilience and sustainability will be undertaken to understand the concepts, related challenges and the link between resilience and sustainability. A content analysis is defined by Mouton (2001:165) as "Studies that analyse the content of texts or documents…Content refers to words, meanings, picture, symbols, themes or any message that can be communicated". Moreover, the sustainability challenges in the City of Windhoek will be explored by means of documentary research.

A literature review is an important part of any study and it aims at providing an overview of what has been done in the field of study by reviewing existing scholarships or "available body of knowledge" (Mouton, 2001: 86-87). The purpose will be to convey to the reader, the knowledge and ideas that have been compiled and the strengths and weaknesses of a topic (Taylor, n.d.). Mouton (2001: 87) suggests the following five reasons why a review of existing scholarship is important:

- *To ensure that one does not merely duplicate a previous study.*

- *To discover what the most recent and authoritative theorising about the subject is.*
- *To find out what the most widely accepted empirical findings in the field of study are.*
- *To identify the available instrumentation that has proven validity and reliability.*
- *To ascertain what the most widely accepted definition of key concepts in the field are.*

Moreover, a qualitative enquiry will be done by means of an analysis of the content of national and local policy documents and plans. The results of the study will be used to make recommendations for building urban resilience and promoting sustainability in the City of Windhoek.

Hsieh and Shannon (2005) define qualitative content analysis as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns", thus qualitative content analysis goes further and analyses the different texts into an efficient number of categories with similar meanings. Mouton (2001: 166) suggests that a qualitative content analysis is very useful for research involving large volumes of text.

1.5 Chapter outline

Chapter 2 uses a literature review to explore the concepts of sustainability and development and sustainable development – its history, constituent parts, and its link to urban sustainability. It ends with a discussion of resilience thinking, including definitions of resilience, resilience assessments, panarchy, resilience in cities, and resilience and sustainability. The chapter also has a look at the current environmental standing of the City of Windhoek, and its socio-ecological systems was explored.
Chapter 3 investigates various forms of sustainability in cities, with case studies in three cities, namely Curitiba, Bogóta and Seattle, from which to draw lessons with regard to their accomplishments of prioritising sustainability. These cities have successfully

transformed themselves into sustainable cities through integrated planning, public participation and improved transportation.

Chapter 4 describes the environmental setting of Windhoek, while chapter 5 describes the policy and legal framework for sustainability and resilience in Namibia and its capital city of Windhoek.

Chapter 6 answers the first and second research question by discussing the sustainability challenges in Windhoek, and whether current policies and plans are sufficient for addressing the sustainability challenges and to build urban resilience.

Chapter 7 presents the conclusions and recommendations on answering the last research question "What mechanisms are required to address the urban resilience and sustainability challenges in Windhoek?"

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to study the concepts of sustainability and complexity of cities. The systems approach in complexity is also explored and this chapter will review the concept of resilience thinking and the resilience concept across different disciplines namely, Engineering- Ecological-, Evolutionary- or Socio-ecological-, Social- and Economic resilience. Also, a resilience assessment framework as outlined by the Resilience Alliance Workbook, will be described. Moreover, the Panarchy model of resilience and resilience in cities will be explored and the relationship between resilience and sustainability will be discussed. Lastly, the 100 Resilience Cities concept will be reviewed.

2.2 Sustainability and development

2.2.1 Sustainability

The term "sustainability" was originally used in the context of fisheries, forestry and groundwater. However, more recently it has been used to link development with environment (Rogers, Jalal & Boyd, 2008: 22). Recently in development, much focus has been placed on Sustainable Development (SD) and Bell and Morse (2003: 1) explain that "at the turn of the century SD has become the dominant paradigm within development". The concept of sustainable development differs from that of sustainability, in that 'development' shows progressive change, while 'sustainability' indicates the maintenance of a steady state system, although this cannot always be said to be correct, because it can be reasoned that all living systems are constantly changing (Bell & Morse, 2003: 1).

The sustainability criterion explains that, at a minimum, future generations should not be left worse off than present generations (Tietenberg & Lewis, 2009: 98). There are degrees of sustainability that range from weak to strong, based on the capital approach, where capitals are those inputs required to create services and materials for economic production. It thus follows that for as long as there is the necessary capital, economic

processes will continue (Stern, 1997: 150-151). Capital can be further subcategorised as described in Table 2.1 that follows.

Capital theorists agree on the need for sustainability, but disagree on the minimum set of necessary conditions for achieving it, and on the degree of substitutability between natural and the other forms of capital – "artificial capital" (Stern, 1997: 150).

Table 2.1: Forms of Capital (adapted from Stokols *et al*., 2013 and Stern, 1997)

Material Resources	Economic/financial capital	Financial assets for enhancing productivity
	Natural capital	Aggregate of natural resource stock that yields inputs for services or supplies to the economy
	Human-made environmental capital	Physical resources designed and built by humans
	Technological capital	Machinery, equipment, digital/communication devices
Human Resources	Social capital	Relationships among people that facilitate action
	Human capital	Capacities of persons, including skills and information
	Moral capital	Investment of personal and collective resources toward justice/virtue
	Institutional capital	Organisations and knowledge essential for the organisation and reproduction of the economy

Weak sustainability calculates the value of the aggregate capital stock and assumes "perfect" elasticity of replacement among natural and artificial capital (*ibid.*), i.e., decreases in natural capital may be traded off for growths in artificial capital (Tietenberg & Lewis, 2009: 98-104). It is focused on the overall portfolio of wealth bequeathed to future generations (Atkinson, 2008: 243).

Strong sustainability, on the other hand, is directed at preserving the natural environment, with the maintenance of distinct stocks of combined natural and artificial capital, and no replacement among "critical natural capital" and artificial capital (*ibid*: 151), or even partial replacement among natural and artificial capital. However, one should not assume that natural resources may be substitutes for each other, e.g., mineral resources vs water or clean air.

Socio-ecological systems are defined as "any system composed of a societal (or human) component (subsystem) in interaction with an ecological (or biophysical) component" (Gallopin, 2003: 13-15). The sustainability of the whole socio-ecological structure is desirable due to the inter-linkages that exist between society and nature, consistent with the concept of strong sustainability. Cities should thus strive for strong sustainability in order to preserve the natural environment on which we are reliant.

2.2.2 Development

As explained by Gallopin (2003: 7-19), the word "development" does not have to refer to quantitative growth, but can also mean qualitative growth. In the case of sustainable development, it is the improvement of the social-ecological system that does not essentially necessitate an increase in energy and material usage, which needs to be made sustainable. According to Ness (1997: 17), development mostly implies economic development that is an increase in human activity. Moreover, economic development presupposes economic growth, but growth is not always sustainable. Sustainable development should therefore rather lead to the sustainable growth of human productivity, and that will support the quality of life for both humans and ecosystems; such a trajectory will lead to a strong socio-ecological system that will be able to produce and test, whilst profiting from opportunities created while in a "fail-safe" mode

(Holling, 2001: 402). In order to link the population with sustainable development, Ness (1997: 17-20) suggests five propositions, namely:

i. ***Development is an imperative***. It is important for all nations to promote and increase human productivity as this is the only way to improve the living standard of their citizens.

ii. ***Development is a means to improve the quality of life of people***. It is up to governments to implement national policies and dimensions to enable proper planning and execution that will define the benefits that citizens will derive from national wealth.

iii. ***Development is for future as well as present generations, therefore it must be sustainable***. The promotion of sustainable development is the responsibility of national governments. Both development and conservation are important parts of sustainable development and are inseparable. Therefore, national governments should ensure that the present generations benefit from development and thereby warranting that future generations will benefit from conservation. National development plans and projects should enforce environmental conservation in order to ensure sustainable development.

iv. ***Planning and implementing strategies for sustainable development requires linking together a wide range of specialised skills***. Specialisation enhances skills and increases the capacity to do things well. Sustainable development planning requires that specialised development, environment and populations agencies be interconnected.

v. ***Effective planning and implementation in population and sustainable development requires broad popular participation***. In order for development to succeed national governments need broad participation. Participation ensures that vast local knowledge and information are incorporated into the planning and implementation processes, adaptation into local conditions are improved and more locals will show commitment to the achievements of the plans.

2.3 Sustainable development

2.3.1 History of sustainable development

Historically, changes in population-environment relationships were more gradual and geographically limited. However, ocean transportation in the 15th and 16th centuries

united the earth in a more human dominated ecosystem. During the 18th century industrial activity was introduced, which led to fundamental change concerning the population-environment relationship as natural resources and food was now more in demand. This brought about dramatic environmental changes. Moreover, at the end of the 19th century there was a rapid increase in these trends. The internal combustion engine was invented, and the mining of fossil fuel gave rise to an urban industrial society. During 1945-1950 rapid changes in technology and human social organisation led to a population-environment relationship that was unsustainable. This modern unsustainability was characterised by rapid population growth and high resource consumption which was unequally distributed worldwide (Ness, 1997: 9-12).

According to Mebratu (1998: 500-501), the notion of sustainable development already became apparent in the 1960s and 70s when the world woke up to the threat of global pollution and limited resources. In 1972 the UN Conference on Human Environment was held in Stockholm, where the importance of environmental management, as well as the use of environmental assessments as an environmental management tool was recognised. A group later known as the "Club of Rome" produced a report that pointed out that the "industrial society was going to exceed most of the ecological limits within a matter of decades" should the economic growth that prevailed in the 1960 and 70s continue at the same pace (Mebtratu,1998: 500-501). Hattingh, (2001: 4-5) further explains that the realisation of this environmental concern in the 1970s was followed by various reports of which the most important were, "The Limits to Growth" by the Club of Rome and "A Blueprint for Survival", first published as a special edition of The Ecologist in January 1972. Reports associated with conferences, such as the Earth Summit in Rio de Janeiro in 1992, were informative and the most important of these were the "World Conservation Strategy" of 1980 and "Our Common Future" of 1987, also known as the Brundtland Report and "Caring for the Earth". The latter provided the most common definition of sustainable development, namely,

> "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*".

The report is premised on the "concept of needs" with emphasis on the "essential needs" of the poor inhabitants of the world, as well as on the boundaries enforced by the "state of technology and social organisation" on the environment to meet the current and future needs. According to Norton (1992: 99), the intention of the Brundtland definition

was supposed to be impartial toward humans and nature, but the description focussed more on humans. It gives the impression that nature, as a resource, is only important when used by humans, and that the use of these natural resources by humans is infinite. Also, the report gives the impression that new technologies and social organisation can overcome or replace the limitations to the use of the natural environment. Bartelmus (2003: 61) criticises the Brundtland report because it fails to specify the needs, or the specific purpose of the environment, and therefore he argues that businesses use sustainable development as an opportunity for invention, and governments use it to relax objections to economic growth, whilst certain public groups use it as defence against globalisation.

After the Brundtland report, sustainable develop is still regarded an important concept as a conference on sustainable development (Rio+20) was again held in Rio de Janeiro in 2012 where the outcome was the agreement to set sustainable development goals (Holden, Linnerud & Banister, 2014: 130).

With regard to the different views of sustainable development, Hopwood, Mellor & O'Brien (2005: 41-43) explain that it is interpreted differently by different groups of people. However, all of them are essentially asking the question, "What is the link between current wealth and future wellbeing?" and a further question, "How much wellbeing and opportunities faced now must be conserved for the future?" (Atkinson, 2008: 242).

Holling (2001: 399) describes sustainable development in terms of adaptive capability and opportunity as follows:

> "*Sustainability is the capacity to create, test, and maintain adaptive capability. Development is the process of creating, testing, and maintaining opportunity. The phrase that combines the two, "sustainable development", therefore refers to the goal of fostering adaptive capabilities while simultaneously creating opportunities. It is therefore not an oxymoron but a term that describes a logical partnership*".

The concept of sustainable development has influenced national and international policies and being a fundamental element in numerous policy documents, has led to a

widening of the discourse of the concept, resulting in a wide variety of definitions and numerous different interpretations (Mebratu, 1998: 494). With "sustainable development" having different meanings to different groups of people and being widely contested, it fits the description of a boundary object by Star and Griesemer (1989: 393), namely, it is both flexible enough to be interpreted differently across boundaries, and firm enough to maintain its integrity and form.

2.3.2 Components of sustainable development

According to Rogers *et al*. (2008: 42-45), sustainable development has three dimensions, namely, economic, environmental and social. Individually, dimensions are given equal consideration to ensure the sustainability outcome desired. Moreover, the three dimensions can be examined individually, and the economic approach is described as maximising income while maintaining or increasing capital stock, while the ecological approach is described as the "maintenance of the resilience and robustness of biological and physical systems". Figure 2.1 below is the generic Venn diagram used most often, with details added to illustrate the aforementioned description.

Figure 2.1: Illustration of the three dimensions of sustainable development (Zucca, G., Smith, D.E & Mitry, D.J, 2009: 190)

The phrase "triple bottom line" (TBL) was primarily coined in 1994 (Elkington, 2004: 1; Elkington, 2018: 1). It was intended to describe three different and separate bottom lines that would measure the performance of a company over a period of time, and ensure that it was taking account of the full cost of its operations. One "bottom line" would be the traditional business account – its profit and loss account. The second would be the bottom line of a "people account"— the company's social responsiveness, while the third would be the bottom line of the company's "planet" account — its environmental responsiveness (The Economist, 2009). However, it was never intended to be just an accounting system; instead its goal was the transformation of capitalism (Elkington, 2018: 5). Because of its lack of success over the last 25 years, the author of this concept has posited a rethink of the TBL approach, and movements towards "a triple helix for value creation, a genetic code for tomorrow's capitalism" (Elkington, 2018: 5)

There are, however, definitions that describe sustainable development as a concept that runs beyond economic, environmental and social boundaries, for instance, the socio-cultural approach is described as upholding the stability of social and cultural systems (Rogers *et al*., 2008: 42-45). As indicated by Spangenberg (2004: 75) sustainable development can be a dynamic optimisation process that includes four dimensions

namely, social, environmental, economic and institutional. Also, Gallopin (2003: 7-19) explains "that the pursuit of sustainability and sustainable development requires an integrated approach comprising the economic, social, cultural, political and ecological dimensions of development across the entire spatial and temporal spectrum". It is thus important to recognise the connection of all the different dimensions that the environment is made up of, and the importance of considering them contemporaneously in order to attain sustainability.

2.3.3 Sustainable development and urban sustainability

With regard to urban sustainability, Allen & You (2002: 16-17) explain that the initial picture of sustainable development, where only the social, environmental and economic dimensions were considered, gives little consideration to the trade-offs that are required in the search for sustainability. Also, the image provided does not take political dimensions into account. They explain that cities are inherently not sustainable as their economic activities are dependent on natural resources outside the built environment. Therefore, the economic, social and environmental goals still apply, but the built environment, as well as the political dimensions and institutional arrangements, should be considered. The five suggested dimensions to be considered in an urban context are as follows (Allen & You, 2002: 16-17):

i. ***Economic sustainability***

   This refers to the ability to put local resources to use for the long-term benefit of communities and at the same time, maintaining the natural resource base, whilst keeping the ecological footprint of the city to a minimum. The entire production cycle should be considered (Allen & You, 2002: 16).

ii. ***Social Sustainability***

   This signifies the fairness, equity and inclusiveness and cultural capability of an activity, that will encourage the equal distribution of natural, physical and economic capital in a community, especially traditionally marginalised groups and those mostly affected by poverty. Cultural adequacy is described as "the extent to which a practice respects cultural heritage and cultural diversity" (Allen & You, 2002: 16-17).

iii. ***Ecological Sustainability***

This refers to the influence of urban invention and consumption on the health, cohesion and universal carrying capacity of a city. (Allen & You, 2002: 16-17).

Physical "Built" Environment

This involves the capacity and efficiency of specialised-structures and technologies, and the urban built environment to support human life and productive activities without harming the natural environment (Allen & You, 2002: 16-17).

iv. ***Political sustainability***

This pertains to the quality of the government systems and frameworks guiding the four previous dimensions of sustainable development. This sustainable development dimension entails public participation in decision making (Allen & You, 2002: 16-17).

From the aforementioned, it is clear that these dimensions must be studied in urban environments for promotion of sustainability. The political dimension is important, as policies and frameworks guide governments towards sustainability. Robert Solow in Van de Veer and Pierce (2003: 441), explains that there is a twofold connection between the environment and sustainability issues and to prevent future generations from suffering from the current unsustainable levels of consumption, the current natural environment needs to be protected by public policy. According to the World Bank (2012: 2), development has for the last 250 years come predominately at the cost of the environment and what is needed now is green growth, described as "growth that is efficient in its use of natural resources, clean in that it minimises pollution and environmental impact, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters". Environmental damage is beginning to threaten growth prospects (World Bank, 2012: 2) as is evident with the recent droughts experienced in Southern Africa. Will it be likely, then, to design urban systems that lessen threats, and that will improve capacity for responding to surprise, shocks and system change? Therefore, it is important to build urban resilience against uncertain environmental changes, to ensure sustainable cities so that they are healthy socio-ecological systems that can invent, experiment, innovate, and benefit from opportunities that are created, while being protected from destabilisation of the systems (Holling, 2001: 402).

2.3.4 Complex nature of socio-ecological systems

Complexity theory indicates that "the world is more like an organism, growing, evolving and adapting to its environment and that policies fail because of random events, unanticipated technological change or patterns in the economy" (Innes & Booher, 2000: 178). Complexity is discussed in large numbers of urban literature, and cities are treated as complex systems (Uprichard & Byrne, 2006: 665). Also, the complex nature of social-ecological systems is frequently recognised and with regard to socio-ecological systems, uncertainty resulting from non-linear interaction draws much attention (Audouin, et al., 2013).

Bai *et al.* (2016: 71-72), explain that the system approach in a city entails many important characteristics. These are described as follows:

"

- *Cities are open systems, continually exchanging resources, products and services, waste, people, ideas and finances with the broader world,*
- *Cities are complex, self-organising, adaptive, and constantly evolving.*
- *Cities encompass multiple actors with varying responsibilities, capabilities and priorities, as well as processes that transcend the institutional compartmentalisation of city administration.*
- *Cities are embedded in broader ecological, economic, technical, institutional, legal and governance structures that often constrain their system function, which cannot be separated from wider power relations.*
- *Urban processes-physical, social and economic are causally interlinked, with interactions and feedbacks that result in both intended and unintended consequences.*

According to Meadows (2001: 61), it is unrealistic to try to control complex systems in a way that you would want them to operate. However, systems can be designed and redesigned. To do this, we should envision the future and try to discover how the properties of the system and our values can work together in order to develop a better system. Meadows (2001, 62-63) suggest that to understand and work with systems it is important to *inter alia* acknowledge that real systems are interconnected and therefore not only the needs of the human race should be taken into account, but the

whole global ecosystem matters, and also it is important to acknowledge that the world is complex and humans have a tendency to be attracted to straight lines and uniformity. However, part of us realise that nature designs fractals with much detail on different scales. Moreover, Meadows (2001, 61) also indicates that policies that will be able to adjust to the changing system should be designed. Specifically, these policies should contain feedback loops and meta-feedback loops to be able to alter, correct and expand loops when needed.

Auoudin *et al*. (2013) clarify that the theory of complexity reveals the shortcomings of traditional scientific methods that are based on a reductionist approach. When studying complex systems, the distinction between the system and its boundaries are not predetermined, because the systems are open and comprise elements that are interlinked. It is therefore important that the researchers determine the extent of the system to be studied by determining the boundaries. It is, however, important to note that the elements excluded from the studies interact in a nonlinear way, and may have effects on the system being studied. Also, the boundary definition cannot be made entirely factually as it involves choices that are value based. Therefore, when studying social-ecological systems, different knowledge types should be considered, i.e. empirical, pragmatic and normative or value based. In addition, the objective of the study on the social-ecological system also forms part of the scope and in most cases this objective relates to promoting sustainability in such systems (Audouin *et al.*, 2013).

2.4 Resilience thinking

Resilience thinking has changed the approach to sustainability from "how to achieve and maintain stability, manage resources", increase human wellbeing and enhance economic growth, to how to deal with the changing environment, disturbances and uncertainties (Ernstson, *et al*., 2010: 531; Xu *et al.*, 2015:123-124). Resilience is not a new concept; it developed with numerous, interrelated meanings in "art, literature, law, science and engineering", with the core meaning of the Latin *resi-lire*, "to spring back" (Alexander, 2013: 2710). The etymology of the word, from the 1st century through to the 21st, is illustrated in Figure 2.2 (Alexander, 2013: 2714). The term was initially used

by physical scientists to describe the features of a coil, and to define the firmness of various materials and the capacity of these materials to resist external shocks.

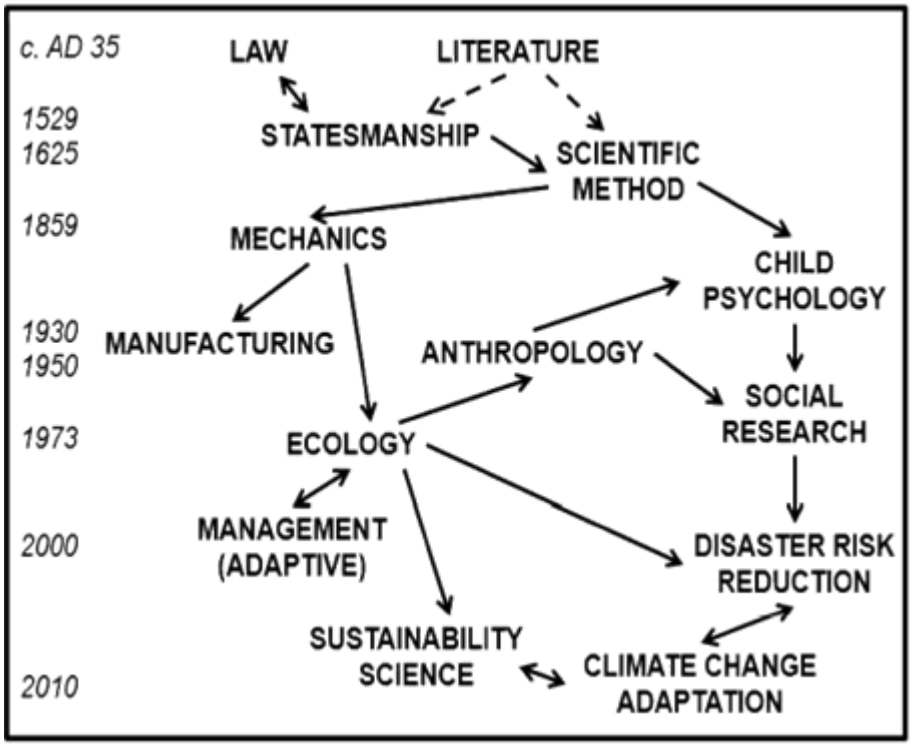

Figure 2.2: Schematic diagram of the evolution of "resilience" (Alexander, 2013)

It was only in the 1970s, together with the escalation of systems thinking, that resilience was introduced into ecology, with Crawford Stanley Holling, a Canadian theoretical ecologist, drawing attention to different assumptions of equilibria and dynamics, and the "tensions between efficiency and persistence," between "constancy and change, and between predictability and unpredictability" (Holling, 1973; Gunderson, 1999). Before this, Tansey (1935) had based his inventory of systems on how a system is able to maintain its composure over time and, in the event of disruption, it was assumed that the system would return naturally to equilibrium.

The resilience approach is now applied in many different academic areas for instance engineering, psychology, economics, social sciences, ecology, environmental sciences, business and innovation, each with their own interpretation (Bahadur, Ibrahim & Tanner, 2013: 1); for example, "power/knowledge supporting liberal governance" (Zebrowski, 2013: 172). It speaks in general to the continued ability of an individual, group or structure to adjust to stress, so that it continues to function or recover its

capability to function during and after the stress. Moreover, the similarities in the different interpretations are coupled with considering the responses to shocks, surprises, unforeseen or hazardous disturbances (Davoudi *et al*., 2012: 300; Bahadur, Ibrahim & Tanner, 2013: 1; Xu, Marinova & Guo, 2015: 123-124). Resilience as a concept for assisting global environmental change was first deliberated on at the 2002 World Summit on Sustainable Development in Johannesburg (Olazabal, Chelleri & Waters, 2012: 10).

2.4.1 Definitions of resilience

Like "sustainable development" and "sustainability", "resilience" is also a contested term, maybe even "a vacuous buzzword from overuse and ambiguity" (Rose, 2007: 384), while Pickett *et al.* (2004: 369) proposed resilience as a metaphor, to connect ecology and urban planning. Definitions of resilience in different frameworks are presented in Table 2.2, from Xu *et al*. (2015: 125), and elaborated upon in the sections below. The impact of these various definitions is summed up by Alexander (2013: 2713) as follows:

> "*There is now a plethora of literature on resilience, especially regarding the persona of individuals, and above all children; the properties of metals, plastics, fabrics and yarns; the integrity of ecological and environmental systems; and the ability of communities to face up to and address disaster risks, as well as their capacity to adapt to climate change. Not all potential users of the term are happy with this situation, and some feel that adoption of the term, or perhaps the concept, has done more harm than good*".

2.4.1.1 Engineering resilience

In policy terms, "the time needed for a system to bounce back to its original state" is an important factor. Engineering resilience can also manifest itself in adaptation measures that are designed to shield against climate vulnerability. Therefore, the engineering resilience framework links well with the understanding of adaptation as a goal (Davoudi *et al*., 2012: 326).

In an urban planning perspective, engineering resilience would be if a city, town or settlement can recover the former functionality of its population, infrastructure and institutions after disasters or other external stresses. Moreover, engineering resilience is concerned with preventing disturbances and disasters and highlight "efficiency,

control constancy and predictability" that is essential for effective designing. These characteristics are typical of systems where uncertainty is not considered to be an issue (Barnes & Nel, 2017).

However, such apparent stability may collapse if social, economic and political changes are not made when necessary for survival (Klein, 2002: 17).

2.4.1.2 Ecological Resilience

The difference between engineering resilience and ecological resilience is that ecological resilience accepts the presence of different stable states (*equilibria*) and the ability of the system to adapt into alternative areas, whilst engineering resilience organises around a single equilibrium point (Zebrowski, 2013: 165, Davoudi *et al.*, 2012: 300, Xu *et al*., 2015: 125). Ecological resilience can therefore be described as multi-equilibria resilience (Barnes & Nel, 2017), albeit adaptation and change only at the margins.

2.4.1.3 Evolutionary- or socio-ecological resilience

Evolutionary resilience accepts that the nature of structures may start to differ over a period of time, whether there is an influence from the outside or not (Davoudi *et al*., 2012: 302). Therefore, a socio-ecological system does not necessarily have to return to "normal", but the complex can change and adjust according to the different tensions. It conceives the world as being intricate, non-linear, self-organising, unpredictable and uncertain (Davoudi *et al.*, 2012: 302), defined by Xu *et al.* (2015) as

> "*The capacity of a system to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes*".

Barnes and Nel (2017) explain that socio-ecological resilience is the same as evolutionary resilience, and that it is connected to the notions of social-complex adaptive systems. They explain further that the evolutionary or socio-ecological resilience acknowledges that urban areas are intricate human or socio-ecological systems that actively connect with various natural structures at different stages, and different scales. Also, because towns, cities, as well as settlements, are complex socio-ecological systems, adaptation and transformation are fundamental. Therefore, the behaviour of a socio-ecological system is defined by the nature of the different

connections rather than the different sections of the socio-ecological system (Barnes & Nel: 2017).

2.4.1.5 Social Resilience

Social resilience is also described as the capacity of individuals and groups to respond and adapt to changes, which can be certain or uncertain (Olazabal, Chelleri & Waters, 2012: 11).

2.4.1.6 Economic resilience

Economic resilience can be described as the ability of a system to allocate resources and deliver essential services irrespective of market or environmental shocks. Moreover, the capacity of the production structure to recover from shocks is also important (Xu et al., 2015: 125). Also, Hallegate (2014: 2) describes economic resilience as the capacity of an economic system to lessen welfare losses for a disaster of a particular intensity, or as described by Jha, Miner and Stanton Geddes (2013: 11), economic resilience can refer to the communities' economic diversity, such as the employment, or number of businesses and their ability to function after a disaster.

Economic resilience can thus be supported by proper policies and action plans for mitigation and adaptation to the effects of disasters.

Table 1.2: Definitions of resilience in different contexts (Xu *et al*., 2015:125)

Term	Definition	Interpretation Example	Reference
Psychological resilience	*A set of combined abilities and characteristics that interact dynamically to allow a person (especially children and a family) to bounce back, handle successfully, and function above the norm in spite of significant stress or adversity*	*Family resilience seeks to identify and foster key processes that enable families to cope more effectively and emerge harder from crises or persistent stresses, whether from within or without the family*	*Rutter 1993; Tusaie and Dyer 2004; Walsh 1996; Xu et al., 2015:125*
Resilience engineering	*The intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions*	*Refers to the ability to perform without failure; the focus is on expected and unexpected conditions of functioning for a material or system; it is also used as an alternative or a complementary view of safety*	*Hollnagel et al. 2006, 2011*
Engineering resilience	*The ability of systems to anticipate, recognise, adapt to and absorb changes, disturbances, surprises and failures*	*It focusses on the stability of systems near an equilibrium state and maintaining efficiency of system functions; in this case, resilience can be measured by the stability of the system, i.e. the time the system takes to return to the previous steady state*	*Holling 1973; Ludwig et al. 1997; Xu et al, 2015: 125; Davoudi, Shaw,Heider, Quilan, Peterson, Wilkonson, Fünfgeld, McEvoy, Porter & Davoudi, 2012: 300*
Ecological resilience	*The measure of the persistence of systems and their ability to absorb unforeseen changes and disturbances and still maintain the same relationships between populations or state variable,s as well as essential functions, structures, processes, and feedbacks*	*It assumes that there exist multiple stable states (equilibria) in ecological systems, thus ecological resilience means the tolerance of the system to perturbations that facilitate transitions among those stable states*	*Holling 1973; Gunderson and Holling 2002; Walker et al. 2004; Barnes & Nel, 2017; Zebrowski, 2013: 165, Davoudi et al., 2012: 300, Xu et al., 2015: 125*
Social resilience	*The ability of communities to withstand external shocks, mitigate and recover from hazards*	*It emphasises the time it takes to recover from stress and also most importantly the access community has to critical resources such as water, land, finances and human skills*	*Adger 2000; Bruneau et al. 2003; Langridge et al. 2006; Xu et al., 2015: 125*
Economic resilience	*The ability of the system to withstand either market or environmental shocks without losing the capacity to allocate resources efficiently, or to deliver essential services*	*It emphasises the functionality of the market and supporting institutions, as well as the production system to recover from shocks*	*Perrings 2006; Xu et al, 2015: 125.*
Social-ecological resilience	*The capacity of a system to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes*	*It points out that resilience is an essential property for societies to survive from changes. The system needs to keep this property by retaining its functions, structure, and capacity of self-organisation and learning*	*Carpenter et al.,2001; Resilience Alliance 2012; Davoudi et al., 2012:302; Barnes & Nel, 2017*

2.4.2 Resilience assessment: Roadmap to resilience

Cities are complex, adaptive social-ecological systems, and resilience, or adaptive capacity, are the emergent properties of these systems (Davoudi *et al.*, 2013: 312) from the interface of various segments of the system or their agents – both first-order and second-order emergent states (Bowers *et al*., 2017: 4). This process of change was described by Davoudi (2012: 304) as "not [..] a being but [. . .] a becoming" after the system has been confronted with disturbances and stresses. Resilience assessment use research from "complex adaptive systems and integrates a set of key concepts to provide an alternative way of thinking about and practicing natural resource management" (Resilience Alliance, 2010).

The Resilience Alliance (2010: 9-50) at Stockholm University has provided a guide to operationalising resilience, through a Resilience Assessment Workbook to develop "a "model of a system that encourages change, variability, and diversity rather than one based upon controlling system component". The three fundamental concepts supporting the workbook are:

- Systems to be managed are connected social-ecological systems,
- These are complex and adaptive, and
- They connect across scales in space and time (Resilience Alliance, 2010).

The social-ecological boundaries of the system that will be assessed must first be defined. These boundaries, which are spatial and temporal, are referred to as the focal system; thereafter, the main issues are identified to create a focus area. The key components of the SES relevant to the focus issues form part of determining "the resilience of what?" To determine "the resilience to what", disturbances, disruptions and uncertainties must be studied.

Understanding of disturbance properties will allow management to work with the disturbance regime, i.e. "the pattern of disturbance events over time", instead of using scarce resources trying to prevent it, and weakening the resilience of the system. Unfortunately, these disturbance regimes can be uncertain at times, and it is important to accommodate and mitigate the disturbances to minimise the impact over the long term. The focal system identified for the resilience assessment may then be linked to a

hierarchy of different systems that influence it and function at multiple scales and at different times. System dynamics studied include the adaptive cycle, the multiple states, the thresholds and transitions. Cross-scale interactions are also considered (Resilience Alliance, 2010: 15-18).

The resilience approach specifies that General and Specified Resilience both be studied. Specified resilience refers to the resilience "of what, to what" whilst General Resilience does not refer to any specific disturbance or any alteration of a specific feature in the system. Governance systems which are made up of dynamic entities that includes various organisations and participants in several areas and in different sizes are considered because the understanding of governance is important to understand the SES relations in the focal system being studied (Resilience Alliance, 2010: 34-37).

Assessment findings are synthesised by means of plotting the information on two conceptual diagrams. The first diagram presents a model of the SES that is the focus of the study. This model shows the Ecological Subsystem and the Social Ecological Subsystem, the external control influencing these systems, the slow and fast changing components of the system and the stakeholders. Every transition of the components involves crossing on or more tipping points, that separate alternative system states, which are referred to as thresholds. The second diagram is constructed around potential thresholds of the main slow variables in the system. Then, general guidelines that are applicable to most SESs can be defined for promoting resilience-based ecosystem stewardship. In resilience-based stewardship, the aim is to "sustain the capacity of the SES to provide benefits to society". Later, transformation will be deemed desirable if the existing ecological, economic and social structures are no longer stable. A transformation has taken place "when there is a change in the key components that define a system and in the relationships between cycles of change and feedbacks across scales". It is important to identify to whom the transformation is desirable (Resilience Alliance, 2010: 27-48).

The Resilience Assessment is most effective when implemented in strategic plans and management processes. The adaptive assessment is used to define what is known and what is not known about various management matters. The aims are therefore to

develop an adaptive assessment and management programme by using the key references provided in the study (Resilience Alliance, 2010: 47-50).

Davoudi *et al.* (2012: 317) indicates that the resilience assessment book can still be improved by developing new tools to assess how power asymmetries within a community affects resilience, developing more tools for strategic planning that focus on the means to direct a shift to a more resilient future, and lastly by giving more examples on applications on resilience assessment.

2.4.3 Panarchy

The Resilience Alliance (2010: 7) explains that socio-ecological systems can be explored by studying various phases of change that natural systems go through. According to Gunderson and Holling (2002:32) most such systems follow a four-phase cycle, namely,

i. "exploitation" (r);
ii. "conservation" (K);
iii. "release" (Ω), and
iv. "reorganisation" (α)

Collectively, these four phases are known as the adaptive cycle, that describe how systems transform over time (Resilience Alliance, 2010: 7). Gunderson (1999: n.pp) described paradoxes within the adaptive cycle, for example, "persistence versus change, flexible versus efficient, resilient versus transformational, and connected versus adaptable" (Davoudi, 2012: 304). Gunderson and Holling (2002) developed the idea of "panarchy" to explain the evolving nature of complex adaptive systems of humans and the natural environment, structured within and across scales in space and time (Allen *et al.*, 2014: 1). Panarchy has a hierarchical structure, but differs from typical hierarchies in that it can be controlled by small scale or bottom-up processes as well. The interactions between scales, or levels, are not within a set of rules, but are guided by multiple sets of connections and impacts. The different adaptive cycles on the different level, or scale, vary in speed, and the larger components of such complex systems maintain system integrity by transforming slower than, and constraining, the smaller components of the system which have shorter adaptive cycles.

Figure 2.3 below illustrates these cycles, as well as "revolt" and "remember" forms of cross-scale interaction. As explained by Gotts (2007) a Revolt connection from a critical change in one cycle, such as an **Ω** phase collapse, can trigger a crisis one level up, while a Remember connection would see the α phase of a lower cycle organised by a higher-level K phase. Revolt situations are typically where the fast and smaller events can overpower slow and larger ones. The effect can cascade to higher, slower levels, if those levels are vulnerable and rigid. However, a Remember interaction can facilitate renewal of the lower level where it draws "on the potential that has been accumulated and stored in a larger, slower cycle phase" (Gotts, 2007).

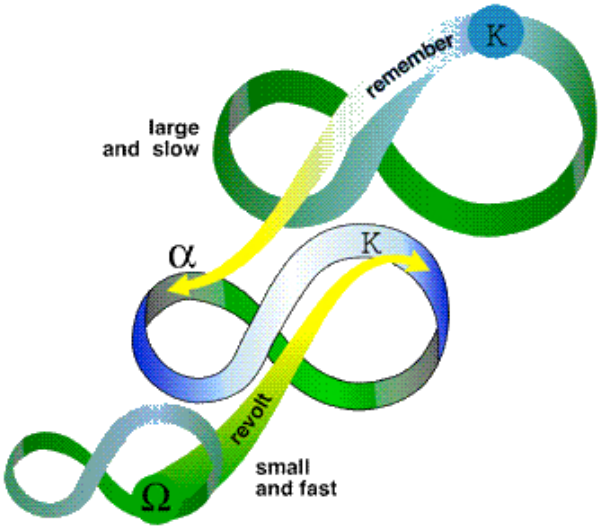

Figure 2 3: Panarchy – cross-scale linkages among adaptive cycles (Resilience Alliance, 2015)

The resilience of a complex system would depend on the interplay between its sub-systems, of which each can consist of individual energetic processes of adjustment, of renewal and regeneration.

Below are three diverse examples of the concept of panarchy applied to real cases:

i. **The urban context**. There is a tension between informality and municipal planning, which is formalised and rigid. Municipalities adopt a spatial development framework (SDF), which sets out how they will manage land use within their borders. Informal settlements, though, are often not established on land designated for human settlements in the SDF – sometimes in dry wetlands,

nature areas, road reserves, or even empty sites reserved for light industrial use. This sets up a tension between the smaller and faster cycle of informal settlements that either appear, disappear or relocate in response to law enforcement action, and the higher, slower cycle of municipal planning that is intended to constrain the system of land use within its borders. Intense and sustained "revolt" from informal settlements can trigger a crisis at the higher level of municipal planning, which responds by either removing these settlements, or "regularising" them – often by amending its SDF to accommodate the new settlement. The various urban settlements in Windhoek must be understood in terms of their multiple formal and informal sub-systems, as well as making up fragments of greater regional, national and international systems. These all will have an impact on the resilience of the City of Windhoek.

ii. **Global warming and Arctic ice.** The warming of the climate on Earth is progressing at a slower rate than the shrinkage of the Arctic Sea Ice, which was triggered by global temperatures rising above a threshold level for the sea ice cycle. Since snow and ice have a high albedo value (a material's ability to reflect sunlight), the reduction of ice cover, and increase in area of dark open water with greatly reduced albedo, may greatly speed up the increase in the temperature of the Earth's climate.

iii. **Democracy capture by elites**. A well-functioning democracy is a panarchy, with a hierarchical control structure, but where the higher and slower level of governance can be influenced by smaller scale processes. The "remember" and "revolt" forms of cross-scale interaction are represented by

   a. **"Remember"**: Governance through policies, legislation and party-political engagements,
   b. "**Revolt"**: Holding Government accountable through elections, street demonstrations, social media and popular campaigns around issues.

However, when the system is "captured" through control by unelected elites, it resists external interactions and can persist as a sustainable, but maladaptive system that is preserved through a perverse resilience. Interconnectedness would be shaped by different means of social control, in which novelty is absent, leaving a "wealthy, tightly regulated, and resilient system" (Holling, 2001: 400). Such a collapsed panarchy would have better capacity to fight external

disturbances and descend into a rigidity trap at the higher level, where organisations become "highly connected, self-reinforcing, and inflexible", and a poverty trap at the lower level, where connectedness and resilience are low, and the prospect for change is not likely, as when societies are affected by situations out of their control over more than one generation (Carpenter and Brock, 2008).

2.4.4 Mitigation and adaptation

Verner (2012: 25) defines adaptation concerns reducing vulnerability of countries, societies and households to the effects of climate variability and change. Moreover, Parry, Canziani, Palutikof, Van der Linden & Hanson (2007,6) of the Intergovernmental Panel on Climate Change (IPCC), defines adaptation as an "adjustment in natural, or human systems, in response to actual or expected climatic stimuli, or their effects, which moderates harm or exploits beneficial opportunities". Moreover, adaptive capacity is defined as "the ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, to cope with the consequences" (Gallopin, 2006: 300).

Mitigation can be defined as "policies and action to reduce the sources of greenhouse gases" (Wreford, Moran & Adger, 2010, 11). Gallopin (2006: 300) further explains that the difference between adaptation and mitigation is that adaptation can be said to be action that operates upon the system itself and mitigation is action that operates upon the "origin and attributes of perturbation". Adaptation with this will not be able to disregard all negative environmental impacts, but could aim to reduce the vulnerability to the effects of climate change and mitigation that will be crucial to mitigate the changes in the surrounding environment by addressing the causes of the climate change. Both of these strategies are crucial for resilience in cities.

2.4.5 Resilience in cities

Wolman (1965: 179) describes the urban metabolic necessities of a city as inputs for home, work and play, such as food, fuel, clothing, construction materials, electricity and telecommunications, and durable goods. Suzuki *et al.*, (2010: 1) indicate that

urbanisation is coupled with extraordinary consumption and loss of natural resources, and three metabolic problems have become acute as cities have grown larger, namely, provision of an adequate water supply, disposal of sewage, solid and liquid waste, and atmospheric and terrestrial pollution. It is estimated that if developing countries consume at the current rate, an ecological resource base equaling four planet earths will be needed to support the growth. Due to the lack of the resource base needed to sustain this shift, cities need to find more efficient ways to meet the needs of their growing populations. A paradigm shift is needed to absorb and sustain urbanisation (Suzuki *et al.*, 2010: 1).

Literature on urban resilience covers diverse research domains, with the most dominant being those of disaster, resource scarcity and climate change impacts (Shah & Ranghieri, 2012: 3), (Olazabal, 2012: 36). A literature review of definitions for urban resilience (Meerow, Newell, & Stults, 2016: 41) identified 25 such definitions, presented in Table 2.3 that follows. The review uncovered that conceptual tensions identified in the literature have not been explicitly addressed and the authors' positions are often inconsistent (Meerow *et al.*, 2016: 42). These conceptual tensions in the 25 definitions are illustrated in Figure 2.4 below, by looking at 6 themes, namely, Characterisation of 'urban', Notion of equilibrium, Resilience as a positive concept, Pathway to resilience, Understanding of adaptation and Timescale of action.

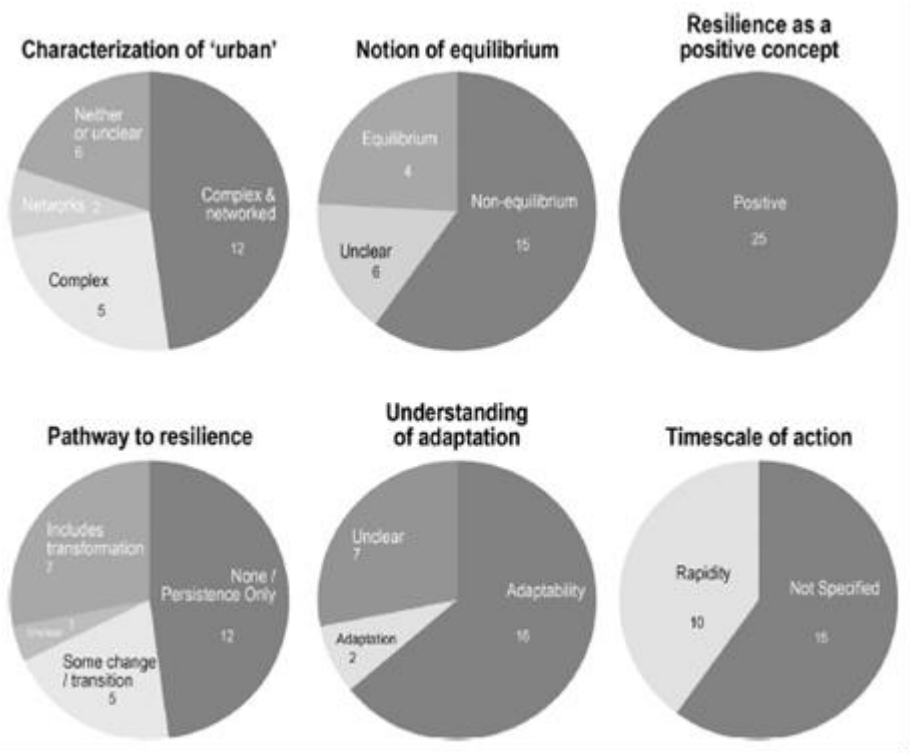

Figure 2.4: Conceptual tensions in definition of "urban resilience" (Meerow *et al*., 2016: 43)

Characterisation of "urban" indicates that in order to define urban resilience, it is important to specify the meaning of "urban". Seventeen of the 25 studies indicated that cities are "complex systems", 14 out of 25 studies indicate that urban systems are composed of networks, while others indicate that cities consist of both systems and networks. Moreover, the Notion of equilibrium refers to the different type of resilience namely, single- state equilibrium (engineering resilience), multiple-state equilibrium resilience (ecological resilience) and non-equilibrium which indicates that a system undergoes constant change and does not have a stable state. The third conceptual tension, Resilience as a positive concept, indicates that 25 studies embrace resilience as a necessary attribute. Pathways to urban resilience stress that the literature indicates three pathways to a resilient state namely, "persistence, transition, and transformation. More than half of the definitions in the study focus on persistence, with 13 out of 25 excluding a mechanism for change. The fourth conceptual tension, the Understanding of Adaptation, refers to differences between specific adaptations to understand threats and more "generic adaptability", which is basically specified as general resilience. The studies indicate that more focus should be placed on adaptive capacity rather than

specific adaptations. The last conceptual tension, relates to the rapidity of recovery as an important characteristic. Only 10 definitions make mention of timescale and the others fail to mention the speed of recovery (Meerow *et al.*, 2016:43-45).

In the light of the inconsistencies uncovered by their literature review, Meerow *et al.* (2016: 45) proposed the following definition for Urban resilience, to integrate these conceptual pressures, or take a firm position on them, but still be flexible and inclusive: "*the ability of an urban system –.and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales – to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity*".

Their conceptualisation of "urban systems" are illustrated in Figure 2.5 that follows. It consists of four major subsystems, namely, "governance networks, networked material and energy flows, urban infrastructure and form, and socioeconomic dynamics" (*ibid.*)

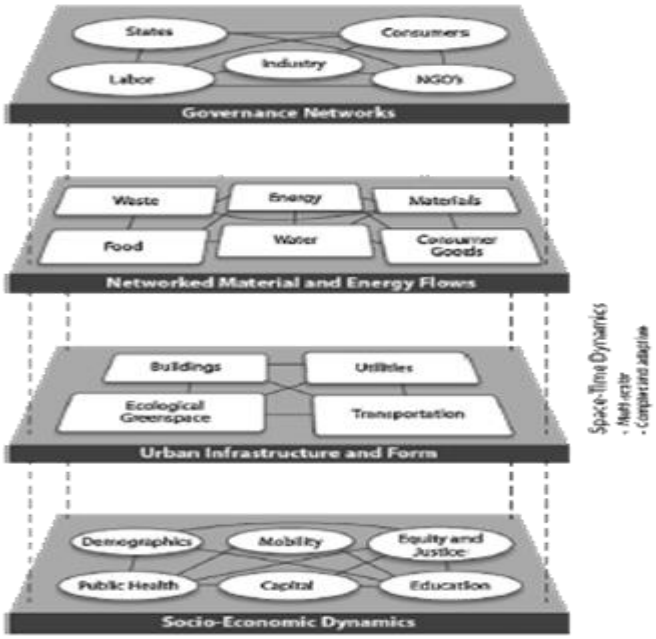

Figure 2.5: Simplified schematic of an "Urban System" (Meerow *et al.*, 2016: 45)

In Figure 2.5 the governance networks refer to a variety of actors and institutions whose decisions shape urban systems. The networked material and energy flows depictmaterials that are produced or consumed in or by an urban system such as water, energy, food and waste flows. The urban infrastructure refers to the building

environment and includes buildings, transportation networks, energy and water grids, as well as urban green space and parks. Lastly, the socio-economic dynamics include monetary capital, justice, public health and education and this outlines the other subsystems and livelihoods and capacities of the urban citizens (Meerow. *et al.*, 2016: 45). The figure illustrates how the different subsystems interconnect with each other. Being in a city, these systems are complex and connect at different scales. In the illustration, the natural environment is not a separate subsystem; it is part of the urban infrastructure subsystem. The natural environment being a vital component of the urban environment, should perhaps have been denoted as one of the major subsystems bringing the total count of subsystems in an urban system to five. It can be reasoned that the urban systems form part of the global system which, in turn, is affected by the uncertainties of climate change. The natural environment is most likely to be influenced first by the disturbing effects of climate change, which will result in adaptation or transformation in the subsystem, causing changes in the whole urban system.

Table 2.2: Urban Resilience is a Contested Concept and Lacks Clarity due to Inconsistencies and Ambiguity (Meerow *et al.*, 2016: 41).

	Author (year)	***Subject area***	***Citation count***	***Definition***
1	*Alberti et al. (2003*	*Agricultural and biological sciences; environmental science*	*212*	*". . . the degree to which cities tolerate alteration before reorganising around a new set of structures and processes" (p. 1170).*
2	*Godschalk (2003)*	*Engineering*	*113*	*". . . a sustainable network of physical systems and human communities" (p. 137).*
3	*Pickett et al. (2004)*	*Agricultural and biological sciences; environmental science*	*101*	*". . . the ability of a system to adjust in the face of changing conditions" (p. 373).*
4	*Ernstson et al. (2010*	*Environmental science; social sciences*	*46*	*"To sustain a certain dynamic regime, urban governance also needs to build transformative capacity to face uncertainty and change" (p. 533).*
5	*Campanella (2006)*	*Social sciences*	*44*	*". . . the capacity of a city to rebound from destruction" (p. 141).*
6	*Wardekker et al. (2010)*	*Business management and accounting; psychology*	*30*	*". . . a system that can tolerate disturbances (events and trends) through characteristics or measures that limit their impacts, by reducing or counteracting the damage and disruption, and allow the system to respond, recover, and adapt quickly to such disturbances" (p. 988).*
7	*Ahern (2011)*	*Environmental science*	*24*	*". . . the capacity of systems to reorganise and recover from change and disturbance without changing to other states . . . systems that are "safe to fail" (p. 341).*
8	*Leichenko (2011)*	*Environmental science; social sciences*	*20*	*". . . the ability . . . to withstand a wide array of shocks and stresses" (p. 164).*
9	*Tyler and Moench (2012)*	*Environmental science; social sciences*	*11*	*". . . encourages practitioners to consider innovation and change to aid recovery from stresses and shocks that may or may not be predictable" (p. 312).*
10	*Liao (2012)*	*Environmental science*	*6*	*". . . the capacity of the city to tolerate flooding and to reorganise should physical damage and socioeconomic disruption occur, so as to prevent deaths and injuries and maintain current socioeconomic identity" (p. 5).*
11	*Brown et al. (2012)*	*Environmental science; social sciences*	*5*	*". . . the capacity . . . to dynamically and effectively respond to shifting climate circumstances while continuing to function at an acceptable level. This definition includes the ability to resist or withstand impacts, as well as the ability to recover and re-organise in order to establish the necessary functionality to prevent catastrophic failure at a minimum and the ability to thrive at best" (p. 534).*
12	*Lamond and Proverbs (2009)*	*Engineering*	*5*	*". . . encompasses the idea that towns and cities should be able to recover quickly from major and minor disasters" (p. 63).*

13	*Lhomme et al. (2013)*	*Earth and planetary sciences*	*4*	*". . . the ability of a city to absorb disturbance and recover its functions after a disturbance" (p. 222).*
14	*14 Wamsler et al. (2013) 3*	*Business management and accounting; energy; engineering; environmental science*	*3*	*"A disaster resilient city can be understood as a city that has managed. . . to: (a) reduce or avoid current and future hazards; (b) reduce current and future susceptibility to hazards; (c) establish functioning mechanisms and structures for disaster response; and (d) establish functioning mechanisms and structures for disaster recovery" (p. 71)*
15	*Chelleri (2012)*	*Earth and planetary sciences; social sciences*	*2*	*". . . should be framed within the resilience (system persistence), transition (system incremental change) and transformation (system reconfiguration) views" (p. 287).*
16	*Hamilton (2009)*	*Engineering; social sciences*	*2*	*"ability to recover and continue to provide their main functions of living, commerce, industry, government and social gathering in the face of calamities and other hazards" (p. 109)*
17	*Brugmann (2012)*	*Environmental science; social sciences*	*1*	*"the ability of an urban asset, location and/or system to provide predictable performance – benefits and utility and associated rents and other cash flows – under a wide range of circumstances" (p. 217).*
18	*Coaffee (2013)*	*Social sciences*	*1*	*". . . the capacity to withstand and rebound from disruptive challenges . . ." (p. 323).*
19	*Desouza and Flanery (2013)*	*Business management and accounting; social sciences*	*1*	*"ability to absorb, adapt and respond to changes in urban systems" (p. 89).*
20	*Lu and Stead (2013)*	*Business management and accounting; social sciences*	*1*	*". . . the ability of a city to absorb disturbance while maintaining its functions and structures" (p. 200).*
21	*Romero-Lankao and Gnatz (2013)*	*Environmental science; social sciences*	*1*	*". . . a capacity of urban populations and systems to endure a wide array of hazards and stresses" (p. 358).*
22	*Asprone and Latora (2013)*	*Engineering*	*0*	*". . . capacity to adapt or respond to unusual often radically destructive events" (p. 4069).*
23	*Henstra (2012)*	*Social sciences*	*0*	*"A climate-resilient city . . . has the capacity to withstand climate change stresses, to respond effectively to climate-related hazards, and to recover quickly from residual negative impacts" (p. 178).*
24	*Thornbush et al. (2013)*	*Energy; engineering; social sciences*	*0*	*". . . a general quality of the city's social, economic, and natural systems to be sufficiently future-proof" (p. 2).*
25	*Wagner and Breil (2013)*	*Agricultural and biological sciences*	*0*	*". . . the general capacity and ability of a community to withstand stress, survive, adapt and bounce back from a crisis or disaster and rapidly move on" (p. 114).*

Urban resilience can also be viewed in the framework of "risk and vulnerability assessments, institutional and social governance structure, resilience in different sectors and transformation of urban areas". In all these applications, an understanding of the complexity of socio-ecological connections in cities is necessary (Olazabal, Chelleri & Waters, 2012:11).

Moreover, globalisation has boosted the interconnection of urban spaces around the world. This interconnectedness between "cities and regions, nationally and internationally", has contributed to the intricacy of urban areas. The cities are no longer locked and self-sustaining structures that can resist disruptions individually. These global cities are now open and characterised by connections from outside and dependencies on other cities. Therefore, disasters in very interconnected urban spaces can be easily spread. Due to these complexities in the modern cities the idea of being resilient and building resilience has increased tremendously (Prior & Roth, 2013: 60-61).

Urban settlements must therefore be managed as complex adaptive systems, with a multiple equilibria approach, to prevent policy responses developed in sectoral silos from having unintended consequences in other parts of the system. For example, trying to alleviate poverty through subsidising transport expenses of poor societies living on the periphery of city may perpetuate fragmented and sprawling spatial patterns of urban settlements. Rather than continue with inefficient public transport and bulk infrastructure development on the periphery, it would be beneficial to support more dense and effectual systems of physical urban development (Seeliger & Turok 2013: 2118).

Resilience in cities is partly determined by their connection with "ecosystems, social networks, governance structures and infrastructure systems that can plan for and respond to a variety of demographic, economic and environmental changes" (Yumagulova, 2012: 21). Meerow *et al*. (2016: 46) suggest the following questions in Table 4 that are related to urban resilience:

Table 2.3: Fundamental questions for urban resilience

Questions to Consider		
Who?	*TRADEOFFS?*	*Who determines what is desirable for an urban system?* *Whose resilience is prioritised?* *Who is included (and excluded) from the urban system?*
What?		*What perturbations should the urban system be resilient to?* *What networks and sectors are included in the urban system?* *Is the focus on generic or specific resilience?*
When?		*Is the focus on rapid-onset disturbances or slow-onset changes?* *Is the focus on short-term resilience or long-term resilience?* *Is the focus on the resilience of present or future generations*
Where?		*Where are the spatial boundaries of the urban system?* *Is the resilience of some areas prioritised over others?* *Does building resilience in some areas affect resilience elsewhere?*
Why?		*What is the goal of building urban resilience?* *What are the underlying motivations for building urban resilience?* *Is the focus on process or outcome?*

Source: Meerow *et al.*, 2016: 46

2.4.6 Resilience and sustainability

Connecting environmental systems with human drivers derives from socio-ecological research (Olazabal, Chelleri & Waters, 2012:10). The Resilience Alliance (2010) explains that because natural resource management matters are not only "ecological or social issues", but are made up of various connected foundations such as political, social, cultural, economic, ecological, technological and other components that interrelate, this system is known as the socio-ecological system (Resilience Alliance, 2010: 6).

Human development cannot be separated from the biophysical environment, since human well-being depends on the biophysical environment. Therefore, focusing on either wealth, inequality or social resilience alone, whilst ignoring human dependency

on the biophysical environment, is not sustainable in the long term. When a social-ecological resilience approach is adopted, stronger focus is placed on the well-being of humans in the biophysical environment and how this relates to sustainability (Folke, Biggs, Norström, Reyers & Rockström, 2016).

Dennis Waitley, the American motivational speaker and writer, came up with the following quote:

> "*Expect the best, plan for the worst, and prepare to be surprised*".

Resilience captures the ability of systems to respond to surprise while maintaining vital functions. Ahern (2011: 341) characterised the shift in thinking from sustainability to resilience as one from a "fail-safe" mentality to one of building "safe-to-fail" systems. Sustainability is about risk averseness (avoidance is top of the impact mitigation hierarchy) and the precautionary principle, which is "trial without error" while risk adaptation is "trial and error" logic – acting without knowing – and the result not what we may have wanted or hoped for (Pizzo, 2015: 137). Sustainability looks at achieving a better future by doing what's right, while resilience accepts imperfect knowledge and an imbalanced world, and posits flexibility and self-learning as the way to go (*Ibid.*).

However, the relationship between resilience and sustainability thinking is multidimensional and explaining the different dimensions can thus be complicated. For resilience to be effective, it must be clearly related to, and be informed by, the various drivers of a system at a particular place, and cross-scale integration (Ahern, 2011: 342).

Resilience thinking moved the sustainability concept from "how to achieve and maintain stability, manage effectively resources, control change, pursue economic growth and increased human wellbeing, to how to deal with changes, disturbances and uncertainties" (Berkes 2007; Ahern 2011). Resilience focuses on the capacity of social-ecological systems to supply ecosystem services, whereas pointers for sustainability normally focus on the present state of the system or service (Folke *et al.*, 2002: 44). Therefore, building resilience in desired ecosystem states can be said to be the most realistic and effective way to manage ecosystems in the changing environment. Also, resilience is considered a precondition for sustainability, in that economic activities can only be sustainable if the life-support ecosystem upon which they depend are able to recover from shock and preserve its functions.

High adaptive capacities in systems enablethem to re-configure themselves without a loss in the essential functions of the system (Folke, *et al.*, 2002: 18). Therefore, strengthening the capacities of societies to manage resilience is crucial for sustainable development. However, resilience – while necessary – is not sufficient for sustainability and it cannot be taken as an objective separately (Derissen, Quaas & Baumgärtner, 2011: 1121-1122).

Xu *et al*. (2015: 125) summarise the similarities and differences between resilience and sustainability in Table 2.5 that follows, where the strong definition of sustainability is relevant to ecological resilience. Resilience and sustainability are linked to each other because for a system to be sustainable, the components of the system will need to be resilient and not be compromised by human activities and disturbances to the extent that it collapses. The starting points for both resilience and sustainability are the same, as we need to decide "of what, to what" for the resilience and sustainability of a system.

Barnes and Nel (2017: 221) explain that resilience and sustainability complement each other because a highly resilient system will promote and strengthen sustainability. Redman (2014) summarises it as follows:

> "*The strength of a sustainability approach is that it systematically examines future options, assigns values to those options via indicators, and customizes its strategies to attain those options. … In contrast, the strength of a resilience approach is that it develops adaptive capacity and/or robustness into the system so that the system can gracefully weather the inevitable, but unspecified, system shocks and stressors. Resilience approach does not require predicting outcomes. Instead, it builds social and natural capital and enhances adaptive capacity to cope with unknown futures … Simply put, sustainability prioritizes outcomes; resilience prioritizes process*".

Resilience, therefore, does not address equity in the same sense that sustainability desires intergenerational equity. Rather, resilience applies to the current state of the system and its thresholds, where stocks can be reduced without the threshold being reached. In addition, resilience does not specify a desirable state and can accommodate a shift of regimes, while sustainability is interested in a specific desirable state to be

achieved or maintained. A shift in regimes suggests that a system should have the ability to adapt (Xu *et al*., 2015: 127-129)

Table 2.4: Similarities and difference between resilience and sustainability (Xu *et al.*, 2015: 127)

	Resilience	***Sustainability***
Similarities		
Objective	*A desirable ecological resilience can sustainably supply sufficient resources and keep its functions to meet the demands of social and economic wellbeing without shifting the regimes in the face of perturbations and unforeseen shocks*	*Strong definition of sustainability includes an important criterion, namely that the stocks of natural capital are maintained at or above existing threshold levels for human wellbeing.*
Dependency relationship	*The basic ecosystem functions should not be affected by human activities or other disturbances beyond their thresholds and socio-economic systems should not collapse because of changes in the states of ecosystems (precondition to sustainability)*	*The sustainability of a system relies on its own resilience, while such resilience depends on a wide range of properties which affect the system itself (goods and services that ecosystems can provide)*
Starting points	*The first important thing for applying resilience thinking to practice is to define resilience in terms "of what to what"*	*The sustainability state of not only social systems but also environmental systems (sustainability of what) to both present and future generations (sustainability to what)*
Differences		
Intergeneration	*Resilience thinking does not conceptually emphasise equity, meaning the resources for next generations are not less than for the current generation*	*Intergenerational equity is the core concept of sustainability, the concerns of which are about previous injustices and the future generations' unreduced accessibility to resources as the current generations has*
Desirable state	*Resilience thinking does not specify explicitly the desirability of a particular state*	*Sustainability is interested in the desirability of any state the system is and how it transitions to another more desirable state*
Culture emphasis	*Culture is considered as part of social mechanisms*	*A strong body of sustainability research exists that acknowledges culture as the fourth pillar and capital distinctive from the natural, physical and human capital*
Methodological approach	*Resilience relates to responses to external factors*	*Sustainability relates to the evolution, and co-evolution, of complex systems that embed natural, social and environmental components and dimensions*

Therefore, it is important that both be considered simultaneously for the survival of systems. Xu *et al.* (2015: 134) emphasise the following general values for building resilience for sustainability management:

“

1. *Using management practices based on local traditional ecological knowledge;*
2. *Designing management systems that ‘flow with nature’;*
3. *Developing local ecological knowledge for understanding cycles of natural and unpredictable events;*
4. *Enhancing social mechanisms;*
5. *Promoting conditions for self-organisation and institutional learning*
6. *Rediscovering adaptive management and*
7. *Developing values consistent with resilient and sustainable SESs*” (Xu *et al*., 2015: 134).

Resilience is essential and a vital component for achieving sustainability, and can potentially link different disciplines, promote discussion “between natural and social sciences and between science and policy” (Chelleri & Marta, 2012: 10). Therefore, local authorities should explore corresponding urban strategies that include resilience as well as sustainability (Olazabal, 2012: 36).

Climate change adaptation and environmental sustainability are both intended to ensure viability of ecosystem services, improve green space, promote urban agriculture and improve building and urban infrastructure. However, adaptation also aims to address economic and equity issues formerly associated with sustainability, such as maintaining economic vitality in cities and supporting the poor and vulnerable communities in a changing climate. Adaptation also concentrates on minimising disaster risks and engages in public health issues (Carmin, Nadkarni & Rhie, 2012: 4).

2.4.7 100 Resilience cities

The Rockefeller Foundation implemented the 100 Resilient Cities (100RC) Programme, a new programme focusing on urban resilience. This helps cities across the globe to become more resilient to physical, social, environmental and economic

challenges affecting the 21st century. The programme focuses on shocks as well as stresses that weaken the fabric of a city daily or occasionally.

Moreover, the City Resilience Framework, developed by the 100 Resilient Cities Programme supports the strategy for the participating cities. This framework aligns ideas derived from ecological resilience rather than engineering resilience and therefore focuses on general theories on resilience from complex socio-ecological systems. Thus, it focusses in maintaining the function of the system, ensuring the output of the system remains, without keeping the system itself intact, by adapting its system to the new situation. Moreover, adaptability and transformability are key in the complex adaptive system and apply to decision-making units (Spaans & Waterhout, 2017: 110-111). Table 2.6 describes seven qualities of resilient systems.

Table 2.6: Seven qualities of resilient system (Spaans & Waterhout, 2017: 112)

Qualities	
Reflective	Reflective systems accept the inherent and ever-increasing change in the world and have mechanisms to continuously change and modify standards based on emerging evidence.
Robust	The robust system consists of well-conceived, constructed and managed physical properties to withstand impacts of hazardous events without significant loss of damage.
Redundant	A redundant system has spare capacity decisively created in a system to accommodate disruption, extreme pressures or surges in demand.
Flexible	This implies that a system can change, evolve and adapt in response to the changing environment.
Resourceful	This suggests that the people and institutions can easily find other ways to achieve their goals and meet demands during shocks and stresses.
Inclusive	Inclusive implies public participation and even the most vulnerable groups need to be included.
Integrated	Integration and alignment between the different systems in the city promotes consistency in decision making and is evident in resilient systems, across different scales of operation.

2.5 Summary

Rapid changes in technology and human social organisation gave rise to an unsustainable world. The concept of sustainable development dates back to the 1960s and 70s when the world recognised the threat of global pollution. However, it is perceived differently by different groups of people and the term is still widely contested. It is thus important to deal with the concepts of sustainability and development separately. Moreover, sustainable development is made of different components, of which the economic, environment and social component are the most popular. More recently, it is argued that outdated methods of studying sustainable development, which only considers the environment-, social- and economic dimensions of sustainability, gives only slight consideration to the tradeoffs required for sustainability and thus the built environment, as well as the political dimensions, should also be considered as important components.

Due to unpredictable environmental changes it is important that cities are ready to adapt to these changes. The term used commonly in resilience thinking has changed the approach in traditional sustainability from "how to maintain" to "how to deal" with resources and the changes that affect them. There are different existing resilience frameworks that are used worldwide to guide resilience programmes used in cities. It is important that governments accommodate this in their policy frameworks in order to build resilience.

Sustainable thinking is shifting from mitigating and avoiding climate change to studying resilience in communities. Resilience is not a new concept. However, it was only in the 1960 that the resilience concept entered the field of ecology. There are similarities between resilience and sustainability as they have similar objectives, dependence relationships and starting points. Also, there are differences between resilience and sustainability in that the generational equity is not a concept of resilience, but is fundamental for sustainability. Moreover, resilience does not require a specific desirable state while sustainability is concerned with a desirable state and the transitions of such state into another more desirable state. Also, various resilience definitions exist of which the socio-ecological resilience is more applicable to cities as cities can be said to be social-complex adaptive systems. To evaluate resilience, the Resilience Alliance

compiled the Resilience Assessment workbook, which stipulates strategies to develop a resilient system that will encourage change variability and diversity rather than merely controlling the system. Since sustainability and resilience are related to each other, it is important to consider both simultaneously, for the survival of systems.

CHAPTER 3 – CASE STUDIES IN SUSTAINABLE CITIES

3.1 Introduction

In Chapter 2, the concept of sustainability was examined, and the idea of urban resilience was reviewed. Also, sustainability and development were defined. This chapter will review the concept of sustainable cities and different approaches to sustainability in cities. Economic-, Social-, Environmental-, Political sustainability and sustainability in the built environment will be discussed. Moreover, the chapter will review cities that have aimed to implement sustainability measures in order to achieve long term sustainability. The City of Curitiba in Brazil, the City of Bogotá in Colombia and the City of Seattle in the United States of America (USA) will be examined.

3.2 Sustainability in cities

For sustainability to be achieved, there should be clear goals for human well-being as well as environmental protection. Thus, the shift toward sustainability should be to meet the needs of the greater human population and to sustain its life support system (US National Research Council, 1999: 83). According to Ravetz (2000: 35), determining what needs to be sustained could be the city itself as a unit, the environment as a whole, human health or the human quality of life whilst individually, these are contained in the triangle of the environment, society and the economy. In order to achieve sustainability, it would be required that the quality or performance goals of each aspect of the sustainable development triangle be respected, known as the "triple bottom line". It ensures that economic activity must be "in the service of" the social activity and it deduces that societies' goals include environmental for the long-term sustainability of the economy, as well as society. The different activities, each with their own goals, may be in conflict at different stages and therefore this gives rise to a fourth category, namely political. The political category will involve conflict resolution by means of rules, institutional frameworks for regulating the economic, societal and indirectly the environmental part (O'Connor, 2006: 286). As more people move to the cities, the built environment develops, making it an important factor for consideration of sustainability.

Allen & You (2002: 17) describe the built environment "as the capacity and aptitude of the urban built environment and techno-structures to support human life and productive activities" without harming the natural environment. These various anticipated factors for the measurement of a sustainable city will now be discussed.

3.2.1 Economic sustainability

Economics is concerned with the satisfying of human population needs with the limited resources available in the natural environment (DEAT, 2004a: 4). Economic growth in countries cannot be fully defined by the needs and wants of the population alone (OECD, 2001: 5). Environmental economics focuses on attaining economic efficiency by providing interventions when market mechanisms appear to fail. Market failure occurs when the property rights to the natural resources are not well defined, when the use of the rights to resources cannot be transferred and when costs of negotiating exceed the benefits of doing so (DEAT, 2004a: 4).

Long term sustainability of economic growth consists of the three pillars of sustainable development as it is subject to the maintenance of basic ecosystem services, a healthy environment and interconnected societies (OECD, 2001: 5). Therefore, economists place their focus on various forms of capital that should be sustained such as "human, man-made, natural and social capital". In turn, Goodland and Ledec (1987: 36-38) emphasise the importance of natural capital in satisfying the basic needs for future generations and suggest that renewable resources should be used in such a way that their future use is not diminished. They indicate that non-renewable resources should be used in a manner, to ensure future availability thereof and lastly, proposes that non-renewable energy sources be used with precaution, for an orderly transition of society to renewable sources. Similarly, Moldan, Janouskova and Hak (2012: 5) specify that the current use of resources should not affect actual future incomes, because sustainability involves equal access by subsequent generations and future economic progress will gradually be more reliant on the "sustained integrity of the resource and environmental base".

Many countries refer to economic growth as a measure to increase human welfare. However, economic activity can have various negative consequences such as transport

emission causing health risks and ozone depletion, declining biodiversity due to the loss of habitat, and inequalities created due to new technologies and production interventions (OECD, 2001: 5). Hence, the strong sustainability criterion is of importance as it stresses that the natural capital should be maintained through time, and cannot be substituted by human, manufactured or social capital (O'Connor, 2006: 289). It is therefore important that sustainable economic growth forms part of the policy documents of countries.

3.2.2 Social sustainability

Social sustainability is for the long-term survival of humans (Moldan *et al.*, 2012: 5). When national policies require multilateral responses through international co-operation, this necessitates that matters of important action be shared and standards for sharing costs be determined. It may be problematic to attain agreements when there are vast inequalities in economic conditions among countries. This is mostly common in developing countries where many people cannot meet their basic human needs due to poverty, malnutrition, illiteracy and a lack of basic services. Therefore, poverty reduction is vital in the quest for sustainable development. However, many of the rural populations are directly reliant on their surrounding ecosystems for food, fuel and shelter, giving rise to the "interactions between the goals of poverty reduction and better environmental protection" (OECD, 2001: 12). It can thus be said that there is constant conflict between humans and nature in especially the developing countries as some communities are dependent on their surrounding environment for survival. It is important that these communities be informed of the value of nature and also for the governments to better understand the needs of the communities. These communities form part of the social capital of the countries.

Social capital, which involves "networks, shared norms, values and understandings that facilitate co-operation within or among groups", is an important factor in attaining collective goals. Social capital can be quantified by investigating community participation and organisational activities, public engagement, volunteer community activities and reported levels of interpersonal trusts. Social connectedness has been linked to lower crime rates, physical and emotional health, as well as the performance

of government institutions (OECD, 2001: 14), and it can thus be said that social capital is an important part of sustainability in cities.

Cities where social sustainability as an urban policy concept is implemented, have included social mix, livability, affordable housing, community services and street life into their policies. Moreover, social sustainability should not represent only certain community classes or neighbourhoods, but should make provision to meet the basic needs of every person in the community, irrespective of their socio-economic standing (Davidson, 2010: 875-876). Moreover, according to Yiftachel & Hedgcock (1993: 140), what is noticeable in a "socially sustainable city" is the "vitality, solidarity and common sense of place among its residents", as well as the lack of intergroup conflict, special segregation and a stable political environment. However, the concept of social sustainability often lacks normative content and is continuously linked to the environment.

3.2.3 Environmental sustainability

The aim of environmental sustainability is to improve human welfare by conserving the raw materials used for the needs of humans. Also, it aims to prevent human waste from exceeding the carrying capacity of the landfills to prevent future harm to humans. In addition, biophysical sustainability is also of importance in order to uphold or improve the life supporting system on earth. "Ecosystems and global-life supporting systems" can be referred to as "environmental infrastructure". The provision of environmental services can only be adequate, if the global ecological systems are in a healthy state. Moreover, biological diversity is a vital component of the environmental infrastructure and a requirement for the majority of services. Environmental sustainability can include climate systems, human settlements, energy systems and terrestrial systems. Also, according to Moldan *et al*. (2012: 6) the OECD Environmental Strategy for the First Decade of the 21st century identifies five inter-linked objectives for environmental policies in the context of sustainable development, namely:

- *"Maintaining the integrity of ecosystems through the efficient management of natural resources*
- *De-coupling environmental pressures from economic growth*

- *Improving information for decision-making: measuring progress through indicators*
- *The social and environmental interface: enhancing quality of life*
- *Global environmental interdependence: improving governance and co-operation*" (Moldan *et al.*, 2012: 6).

Environmental sustainability should form part of policy documents to ensure protection of ecosystem services, which is vital for human survival. Effective policies that will guide government, corporations and communities remain an important concept in sustainable development. Political sustainability is therefore also considered an important approach in sustainable development.

3.2.4 Political sustainability

The publication of "Our Common Future" in 1987 resulted in an extraordinary political discourse by academics of various disciplines, in communities and in corporations. The goal of achieving sustainability is probable if adequate numbers of scholars, practitioners and political actors support a range of methods to endorse sustainability (Sneddon, Howarth & Norgaard, 2006: 253-254).

According to O'Connor (2006: 286-291), politics plays an important part in sustainability because it can be said to act as referee to resolve conflict among the different sectors of sustainable development, due to the different opinions of the social and economic sectors in relation to the environmental sector of sustainability. It is meaningless to investigate the different sectors of sustainable development independently as the many issues have a cumulative connection. The integrated environmental assessment (IEA) has highlighted the interdependencies between the environmental and economic sectors by identifying the characteristics of the environmental pressure, as well as the environmental services. Via this integrated approach, governance is in search of the "double performance criterion" of firstly, the "economic welfare through the production of economic goods and services" and secondly, "the permanence of an ecological welfare base through assuring maintenance of environmental functions". The "social demand" of respect for the environment is

now emerging in principles and practices of corporate social responsibility (CSR). Companies, as they form part of the economic sector, are required to validate that their actions show respect towards the environment and society (O'Connor, 2006: 286-291).

Moreover, O'Connor (2006: 288) explains that governance concepts are disseminated from the political sector where it provides public policy with the aim of influencing the functioning of environmental systems. Three policy domains for governance are determined: firstly, the political-economic domain of governance which supplies economic policy that takes into regard the social and environmental sectors. Secondly, the political-environmental domain where environmental policy is provided with the aim of seeking the role of natural capital to economic welfare, the stability of the welfare base through the maintenance of environmental functions and by emphasising the respect for the environment. Thirdly, political-social sectors seek to organise society around the needs of the economic sector and to safeguard value for all defined systems in a community. In this sector, provision is made for society to make demands toward government concerning civil society, the community, as well as economic and environmental concerns. O'Connor (2006: 291) further suggested that a two-tiered framework for sustainability policy be considered: Firstly, the primary level of analysis that describes the duty of respect toward the different communities. Secondly, the "fairness or unfairness in access to services, distribution of opportunities, vulnerability, stresses and risks (etc.) within each class". Correspondingly, sustainability policy is required to address situations characterised by complexity which can be induced through three considerations that often interfere with each other:

- Scientific knowledge reflecting on complex uncertainties and/or irreversibilities.
- A range of value systems, political and moral convictions and reasoning norms within the communities.
- Risks for high decision making that includes economic interest, national strategic security concerns, or security concerns, for ethical minority groups and the possible costs of environmental change for public health, organism integrity and forthcoming economic opportunities (O'Connor, 2006: 286-291).

Policy goals towards sustainable development need to be clearly defined before implementation is put in place to make societies sustainable (Singh et al., 2009: 191). Policy objectives toward sustainability in the built environment are essential in order to control construction processes which are known to damage the environment. Often development takes place on undeveloped open spaces where the natural environment is destroyed.

3.2.5 Sustainability in the built environment

There is a global concern that construction causes major environmental damages in terms of the natural resources being used in the process, as well as the pollution in the surrounding construction area (Ding, 2008: 451). It is predicted that the sum of urban dwellers will increase, and might reach up to 5 billion by the year 2030. With this density, the extent of economic and social activities, due to urban areas being major consumers of resources, environmental and societal issues are being measured together with the functional and economic characteristics of the built environment (Xing, *et al.*, 2009: 209-210).

Developing countries are challenged with the implementation of sustainability when undertaking infrastructure development that stimulates economic growth. There is a dire need to develop and construct for sustainability, and to achieve these objectives at the micro-level. Sustainability methods have focused mainly on environmental protection. However, according to Ugwa and Haupt (2007: 666) a recent study conducted using the "built environment quality evaluation for sustainability through Time (BEQUEST)" framework, showed that there are several methods that could be used to measure the sustainability of urban activities. Also, it is important that the triple bottom line approach be used when accessing infrastructure projects (Ugwa & Haupt, 2007: 666).

Assessment tools for sustainability in the built environment can be roughly classified into two classes namely, qualitative tools and quantitative tools. Qualitative tools are often based on the auditing of building and entails scores and criteria, whilst

quantitative tools involve production data of materials or energy flows (Forsberg & Von Malmborg, 2004: 223).

Various integrated assessment tools are available to determine the likelihood of achieving the sustainability goals. Also, to illustrate the effectiveness of the actions taken to reach the goals on the approaches described, policy assessments have to be conducted. This approach supports adaptive management by attending to the details of policy implementation (US National Research Council, 1999: 84-86).

The different methodologies and approaches used to regulate and ensure sustainable development have been implemented in various countries worldwide. Three different cities that have prioritised sustainability will now be discussed.

3.3 Examples of cities which have prioritised sustainability

3.3.1 Curitiba

Curitiba has been recognised worldwide as an urban planning success story (Mercier, Duarte, Dominigue and Carrier, 2015: 1455). Macedo (2013: 335) describes Curitiba as a city that became "a symbol of sustainable planning before sustainability entered the lexicon". Moreover, in 2010, Curitiba won the Swedish Globe Sustainability City award and topped the Siemens/Economist Intelligence Unit's Latin American Green City Index. Also, in September 2015, the award to the "Best City in Brazil" was bestowed on Curitiba (Do Rocio Rosário, 2016: 117).

Curitiba, Brazil's eighth largest City with a population of 1.8 million people, is the capital state of Paraná in southern Brazil. It lies in the centre of the metropolitan region with around 3.2 million people. The transformation started 50 years ago when extraordinary development was experienced in Brazilian cities as a result of rural urban immigration. Professionals realised the need for a new approach to deal with the dramatic growth (Do Rocio Rosário, 2016: 114). The renowned quality of life standards in Curitiba and its surrounding areas fascinated migrants from all over Brazil and Curitiba experienced intense development in 1970. The continuous planning process

with an effective administrative system was the only way to control the urban growth (Miranda & Da Silva: 2012: 142).

Do Rocio Rosário (2016: 114-116), indicates that the city of Curitiba is well known for its innovative approach to urban growth, the combination of land use policies and public transportation to promote urban regeneration, preservation of the cultural heritage, as well as the preservation of the natural environment. In particular, Curitiba is well known for the effective public transport network with five well-planned transportation corridors. Curitiba benefited from the federal government before the FIFA World Cup in 2014 because the plans for the majority of upgrades, excluding the stadium, were already in place. Curitiba has a stable municipal governance and has years of uninterrupted city planning. The "Instituto de Pesquisa e Planejamento Urbano de Curitiba" or in English, the Institute of Research and Urban Planning of Curitiba (IPPUC), was created in 1965 and constantly monitors the city's planning process, the policies in relation to the changing political and the economic environment. (Do Rocio Rosário, 2016: 114-116).

The residents of Curitiba are of the opinion that "they live in the best City in the world" (Curitiba, 2010a). The success is attributed to a participatory approach, where all residents are included. The flood water problems of the City were solved by diverting water from lowlands into lakes of new parks and teenagers were employed to maintain the parks. The downtown shopping area was converted into a pedestrian zone, the Rua das Flores, and was decorated with gardens. These gardens were maintained by street children. Shopkeepers agreed to give the street children a food and a small salary in turn for the upkeep of the gardens. Curitiba also has an ongoing recycling project where residents are requested to separate their waste into organic and inorganic. Thereafter, at a recycling plant, that employs handicapped people, recent immigrants and alcoholics, further separation of the recycling material takes place. In Curitiba, two-thirds of its refuse is recycled, which is said be of the highest rates when compared to other cities globally. Also, Curitiba offers tax breaks to builders that include green areas in their projects (Curitiba, 2010a).

Curitiba was thus not led top-down by the Mayor – the approach was effective because it involved partnerships with private companies, NGOs, neighbourhood, as well as community groups (Curitiba, 2010b).

The City of Curitiba sets a good example worldwide of incorporating the different dimensions of sustainable development. The social dimension has received major attention as all members of the community have been involved, including the unemployed street children, immigrants and the handicapped. Also, by recreating the urban transportation system, all members of society can now access different parts of the city, not previously possible. The City of Curitiba has also managed to implement an effective recycling operation that benefits the environmental dimension of sustainability. The incorporation of green spaces into the city also protects ecosystem services, which in turn, will benefit the communities.

3.3.2 City of Bogotá

As recently as the 1990s, the City of Bogotá was considered one of the most dangerous cities in the world, with a high crime rate and raging drug wars. After the appointment of Enrique Peñalosa as Mayor in 1998, his goals were to clean the image of the city and to improve the mobility within the city (Blue & Green Tomorrow, 2014).

Bogotá is a Latin American city with many inequality and poverty challenges. During 1998-2001 Mayor Enrique Peñalosa implemented an extraordinary urban model that contributed to positively changing the attitudes of the citizens of Bogotá. This model also set a great example for many countries in Latin America. The greatest challenge was the creation of equality. Almost 50% of Bogotá consisted of illegal dwellings, on inaccessible land, not suitable for development, although developable land suited for housing developments was available. The city administration created a municipal land bank which acquired land that was then sold to produce quality urbanism, built by private developers. Houses were sold at set prices. Also, the state of the city centre was appalling after illegal traders roamed the public spaces and a 24-hectare residential area located close to the Presidential Palace was a drug hotspot. This area was revamped by introducing social programmes and relocating residents. Thereafter, 600 buildings were demolished and replaced by a 23-hectare public park. Moreover, public open spaces were reclaimed and a main avenue in the city centre was pedestrianised. Another concern was the demand for highways in the city, although only 20% of the inhabitants owned cars. There was thus direct conflict between the space needed for construction

of the highways and space needed for the construction of housing, public schools, parks, pedestrian walkways, bus lanes, and cycle lanes for the poor inhabitants of the City. The decision was then taken to reject the construction of the new highways. Instead, funds were spent in a way to benefit most of the population. The bus system at the time was mostly privately owned, and buses were in a dilapidated condition. The City of Bogotá then implemented a bus-based transit system, similar to the city of Curitiba in Brazil, where the buses operated in physically isolated lanes. Thereafter, several high-quality sidewalks were established that were kept safe by placing bollards next to them to prevent cars from using them for driving. Hundreds of parks were rebuilt, and parkland that was previously privatised was re-claimed. The City managed to build a 250km network of bicycle lanes alone, pedestrian paths and city streets. This increased the use of bicycles from almost 0 to 5%. The safety of the cyclist was considered just as important as the citizens with the expensive cars. In addition, community centres, libraries and state of the art nurseries were built in the poor neighbourhoods to enhance the quality of life for the urban poor (Peñalosa, 2011: 90-95).

The City of Bogotá introduced several policies which resulted in various benefits to the city such as the improvement of air quality, the reduction in traffic related deaths. (Blue & Green Tomorrow, 2014). The new implemented public transport system did however have a few challenges.

The new bus transportation system, the Transmilenio BRT system, was implemented in December 2000 and was designed to operate self-sufficiently with the fares set at a cost recovery level. The 2014 Multi-Purpose Survey, however, revealed that the urban poor spent between 16% and 27% of their monthly income on transport compared to only 4% maximum spent in more affluent areas. Also, the Bogotá Mobility survey of 2011 showed that the population in the lower income groups travelled less and rather walked or used bikes for longer trips. This resulted in the City of Bogotá introducing a subsidy system, whereby personalised smart cards were issued to qualifying beneficiaries. By 2015 some 300 000 had received their smart cards and 200 000 were in actual use. This new subsidy did not interrupt the financial sustainability as the fares were set at cost recovery levels for most of the population and the subsidies were targeted at the urban poor that needed it most. This pro-poor public transit subsidy scheme sets a great example to other cities to understand that the urban poor and

vulnerable groups should not be excluded from the economical, educational, health and cultural opportunities that are provided by greater mobility (Hernández & Peralta-Quiros, 2016: 9-17).

The City of Bogotá has succeeded in implementing a transportation system that works for all community members, including the poorer community members. The needs of the community were clearly assessed, and it can be said that the quality of life of all members of the community has been improved. The introduction of effective policies guided the government in making sustainable development decisions.

3.3.3 City of Seattle

"Moving the Needle" (City of Seattle, 2014) is an environmental report for the city of Seattle with an assembly of high level environmental goals and accomplishments to enable improved tracking and accountability. This report includes the following environmental areas: "Buildings & Energy, Transportation & Land Use, Food, Waste, Water, Trees & Green Space and Climate Change".

Seattle is ranked 1st in the nation for its green building policy and has one of the top green building markets, also hydro-electric power that supplies 92% of its electricity, and it is the leading city in electric transportation. Most of the jobs in the city are in urban villages, thereby minimising travelling time (City of Seattle, 2014: 3-4).

Since 2011, Seattle has also experienced a remarkable increase in bicycle use, and an increase in the number of pedestrians after safety improvements, bike lanes and greenways were created (City of Seattle, 2014: 5-6).

Seattle has realised that the rise in obesity can lead to an increase in mortalities. As a response, the city increased healthy food intake in the early learning centers. Also, more land has been made available to the public for growing fresh food produce to improve food security. In addition, customers have been introduced to local farmers and since then there has been an increase in the consumption of local food (City of Seattle, 2014: 7-8).

Their recycling initiative has resulted in the City saving more than 3 million metric tons of greenhouse gas. By increasing waste for recycling, the amount of refuse sent to the landfill sites has decreased. Also, the city realised that construction and development create a substantial amount of waste and subsequently new requirements have been implemented for future construction, remodeling and demolition of activities in Seattle (City of Seattle, 2014: 9-10).

Moreover, water management has been very successful. Seattle has managed to see a decrease of regional water consumption since 1990. It has a storm water infrastructure in place to effectively manage water runoff. Pollutant removal has increased, and street sweeping is one of the cost-effective ways of preventing pollutants from entering the waterways. Seattle has also introduced a RainWise programme that assists homeowners in reducing polluted runoff, by providing rebates for creating natural drainage solutions on their properties (City of Seattle, 2014: 11-12).

Seattle has realised that green space is important for a healthy and livable city and subsequently more than half the parkland in Seattle consists of natural beaches, forests and wetland. The majority of residents live within a quarter mile of a park. The city is also in the process of restoring parkland and 40% of the goal in this regard has already been achieved. Seattle also uses volunteers to care for natural areas and trees. In addition, more than 1800 trees are planted annually, and some residents are issued with permits to allow them to plant trees at their own expense. The Green Seattle Partnership, a partnership between the City of Seattle, Forterra and community volunteers are supported by businesses and non-profit organisations, with a view to restore and maintain the forested parklands in Seattle. The carbon footprint of Seattle is much lower than in cities of neighbouring countries – the city has a goal of achieving carbon neutrality (City of Seattle, 2014: 13-14).

The City of Seattle is developing a climate preparedness strategy to identify action that will improve the resilience of the city to the changing climate. The climate preparedness strategy focuses on minimising inconsistent impacts on vulnerable groups, enhancing ecosystem services, and maximising cost effectives and economic capability (City of Seattle, 2014: 15-16).

Sustainability and smart growth are important policy agendas in Seattle where the city is built to accommodate future growth (Dierwechter, 2014: 692-694). The policies that have been put in place for the City of Seattle have proved to successfully guide the government into making decisions on sustainable development. The various dimensions of sustainable development have been considered and it can be said that they are upheld in such a way to complement each other, as specified in the triple bottom line approach.

3.4 Summary

The concept of sustainability entails that not only human life is to be maintained, but also the environment, of which humans are part of as a whole. Human life is dependent on ecosystem services of the natural environment for survival. The concept of the triple bottom line needs to be implemented in order to ensure that the economic dimension is "in the service of" the social dimension. In addition, the triple bottom line reasons that societies' goals include environmental sustainability.

The different approaches to sustainable cities to be considered is the economic-, social-, environmental-, political sustainability and the sustainability of the built environment. The different approaches should be incorporated into policy documents that will direct the governments, corporates and communities towards building sustainable cities.

Various cities worldwide have successfully incorporated sustainable development into their policy documents and positive changes have started to show in these cities. For the purpose of this study, the cities of Curitiba, Bogotá and Seattle have been studied to determine their accomplishments in sustainable development. The cities have managed to, amongst other things, successfully improve public transportation, progress in social capital, make improvements to the environment, introduce recycling concepts and effective water saving initiatives. The success of these cities can be attributed to effective policy documents, effective control measures put in place to determine the success of the initiatives implemented and effective reporting that reflect the progress made.

For many cities the concept of sustainability is still relatively new and many challenges towards sustainability still exits. The City of Windhoek will now be studied to determine the sustainability challenges.

CHAPTER 4: ENVIRONMENTAL SETTING FOR WINDHOEK

4.1 Introduction

In Chapter 3 case studies in sustainable cities were discussed. The importance of human well-being, as well as environmental protection in sustainable development, was discussed. Moreover, it was suggested that the different approaches to sustainable cities which should be considered are the economic-, social-, environmental-, political sustainability and the sustainability of the built environment.

Various cities worldwide have successfully incorporated sustainable development into their policy documents and positive changes have started to show in many cities. Chapter 3 studied the cities of Curitiba, Bogotá and Seattle with a view of determining their accomplishments in sustainable development. This chapter will explore the environmental setting of the City of Windhoek based on the five pillars of sustainability discussed in section 3.2.

4.2 Biophysical environment

Namibia is one of the driest countries in the world. The Namib Desert is situated in the west of Namibia and the Kalahari Desert in the east and subsequently more than 80% of the country consists of desert and semi-desert (Lahnsteiner & Lempert, 2007: 441). The City of Windhoek is located centrally in Namibia (Figure 4.1).

Figure 4.1: Locality plan for Windhoek (CoW, 2004: 3)

4.2.1 Topography

The central highlands in which the City of Windhoek is situated, are commonly known as the Khomas Hochland. To the south, it is surrounded by the Auas Mountains, in the west the Khomas Hochland and the Eros Mountains in the east (City of Windhoek, 2009, 7). Moreover, the city is surrounded by a natural south-north trending valley. (City of Windhoek, 2009: 7). This valley is approximately 10km wide and its length is some 70 kilometres. This confined area is known as the Windhoek Basin (City of Windhoek, 1996).

There are prominent ridges and steep slopes in the mountainous areas surrounding Windhoek and therefore most of these areas are natural open spaces with limited to no development. These ridges provide an aesthetically pleasing atmosphere to the residents and are also used for recreational activities by them (City of Windhoek, 2011: 32).

According to the Windhoek Environmental Structure Plan (WESP), these high ridges provide a future for biodiversity in an urban landscape. Numerous streams originate on these high ridges and control water inputs into wetlands, thus protection of these high ridges will ensure normal functioning of the ecosystems. Consequently, the WESP has suggested that these areas be maintained in a natural state and that any development should be subjected to a visual impact assessment and the formulation of mitigation measures. It is also suggested that only strategic service developments be allowed after an environmental impact assessment (City of Windhoek, 2004: 76).

Moreover, the bottom part of the valley in the lowest part of the landscape within which the drainage occurs, should remain as open space and will serve the purpose of providing main links to connect with other open spaces. The broad river valleys – that is the area along the course of the river, up to the slopes of higher lying surrounding ridges – should be protected as they play an important hydrological function. Moreover, activities that may alter these areas can only be allowed once potential impacts have been fully investigated and mitigation measures are in place (City of Windhoek, 2004: 78).

The undulating plain which is described as the terrain that has gentle curves, is the least sensitive and should be targeted for development. The side slopes, bottom part of the valley and broad river valleys are the areas where residences and buildings relating to industrial development have mostly been erected (City of Windhoek, 2004: 79-83).

4.2.2 Geology

The topsoil in Windhoek is relatively thin and not more than one metre deep. Moreover, the underlying rocks consist of marbles, schists and quartzites. Geological faults are present and the springs and thermal underground water that existed when Windhoek was founded can be associated with these faults (City of Windhoek, 2001). The quartzites found south of Windhoek form the main Windhoek aquifer that is a major ground water source for Windhoek. These quartzites are fractured along fault lines and therefore contribute to the infiltration and extraction of the aquifer. In the past, the Auas

quartzites were also used for masonry work, flooring and drywalls and in the landmarks of the City, such as the Christuskirche and Tintenpalast (City of Windhoek, 2009: 9)

4.2.3 Water

4.2.3.1 Groundwater

As Namibia is considered one of the driest countries in Southern Africa, the supply of water is a serious problem in Namibia. The increase in population adds to the threat of water availability. In addition, industrial development also makes demands on the availability of water and can cause ground water pollution that is detrimental to human and animal health (Ruppel & Ruppel-Schlichting, 2016: 25-16). As Namibia is such a dry country where surface water is scarce, ground water is of major importance (Mendelsohn, *et al.*, 2002: 64).

The valley in which Windhoek is situated forms Namibia's central watershed from where large river systems distribute in different directions. Initially, people settled in Windhoek many years ago due to the natural springs that provided water, but these springs later ran dry when pumping of groundwater started in the 1920s (Bäumle, *et al.*, 2011: 77-78). Rainfall in Windhoek is limited to approximately 350-450 mm per annum (City of Windhoek, 2004: 85).

The Windhoek aquifer is an important water source because of its supply and storage potential. The ground water is a water source for Windhoek and several boreholes located in the southern parts of Windhoek are a direct source of water for the water reservoirs (Van Rensburg, 2006: 24).

The City of Windhoek has conducted several studies to determine the vulnerability of the water aquifer and the catchment area regarding disturbance, land transformation and possible pollution points. Approximately 7% of water is sourced from the Windhoek aquifer and in times of drought this figure rises to 27% (City of Windhoek, 2005: 1-6).

The Windhoek aquifer has been over-utilised during the past 50 years and is steadily declining. Moreover, the southern parts of Windhoek have been classified as extremely vulnerable areas, especially along the quartzites in the Auas Mountains. Very little top soil covers these parts, and pollution is most likely to spread at a rapid pace should this

area be used for development. These southern parts of Windhoek should thus be protected from future development to protect the ground water. The City has plans underway to artificially recharge the Windhoek aquifer (Van Rensburg, 2006: 29-31).

The City of Windhoek is planning to strengthen resilience to drought through a water banking scheme called the Windhoek Managed Aquifer Recharge Scheme (W-MARS). This project will expand the capacity of the Windhoek aquifer to enable adaptation to both temperature increases and rainfall variability. The water will be stored underground to prevent evaporation. Also, water will be captured during high rainfall times and banked underground for years of drought (City of Windhoek, 2017: 58).

4.2.3.2 Surface water

Not much surface water is available in Namibia as rain quickly drains away into the ground or is rapidly drained by the ephemeral rivers. The rivers that can hold water are located at the country's borders in the far southern and northern parts of the country. Several man-made dams are important bodies of water for the people of Namibia (Mendelsohn *et al*., 2002: 66).

The bulk of the water in Windhoek is supplied by three dams managed by the National Water Carrier, NamWater. The dams are the Omatako dam, 200km north of Windhoek, the Swakoppoort dam 100 km to the west and the Von Bach dam located more centrally and situated some 70km from Windhoek. These dams supply about 15Mm^3 of water to Windhoek. They have experienced an irregular inflow of water in the past 30 years since then water shortage has become a concern in Windhoek. Additional to the three larger dams, there are two smaller dams in Windhoek, originating from the ephemeral rivers near the city. The two dams are the Avis dam with a capacity of 2.4 Mm^3 and the Goreangab dam with a capacity of 3.6 Mm^3. There is no yield expected from the Avis dam because inflow is not guaranteed. Moreover, a water reclamation plant was built at the Goreangab dam in 1968 to reclaim potable water directly from domestic sewerage. Due to the huge success of this plant, another was built for Windhoek in 2002. The City of Windhoek blends the water from the Goreangab reclamation plant with the water from the Von Bach dam at a ratio of 35% reclaimed water and 65% water from the Von Bach dam (Van Rensburg, 2006: 21-23).

Windhoek has fully utilised its water resources and therefore NamWater and the government is investigating an alternative supply of water by obtaining water from the Okavango River that is located some 800km from Windhoek or/and the desalination of water at the Central coast about 350km away. Moreover, the City of Windhoek has realised the importance of re-using water and optimising the available resources. Consequently, the City is exploring the establishment of an additional direct potable re-use facility at the Gammams reclamation plant. Also, the City of Windhoek aims to minimise technical and non-technical water losses. A unit is being established to develop an improvement and maintenance plan to minimise losses (City of Windhoek, 2017d: 49-50).

4.2.4 Soils

The Windhoek SEA Baseline Status Quo Report indicates that the topsoil in Windhoek is thin, poorly developed and less than one metre thick. Moreover, the report indicates that the soil is the product of alluvial and colluvial deposition of fine sands and silts intermixed with residual quart pebbles. Sand, gravel and cobbles of alluvial origin are mainly found along the main riverbeds and form the thickets soils. The alluvial deposits found in drainage lines are popular for use in construction as they contain high percentages of sand. The soils from the plains are mainly fine-grained sand, gravel and boulder gravel deposits. On the slopes and ridges soil is made up of gravels and colluvial, with quartzite beds and schist bedrock underneath. These soils are prone to erosion during rainy spells, especially in areas where there is limited vegetative cover (City of Windhoek, 2009: 9-10).

4.2.5 Biodiversity

Biodiversity knowledge has evolved since the mid 1990's from purely 'taxonomy' where museum and taxonomists described different organisms and how they relate to each other, to conservation regarding ecological roles and the conservation status of different groups of fauna and flora. This was done because it had been realised that human life and human livelihoods depend on the natural resources provided by the surrounding biodiversity. In Namibia, the government and non-governmental planners know that action needs to be taken and awareness needs to be raised for decision makers and the public (Barnard, 1998: 299-300).

The Windhoek Environmental Structure Plan (WESP) divides Windhoek – including the surrounding townlands – into six habitats, namely:

- The Windhoek Valley
- Riverine Thickets
- Open Water
- High Mountains
- Khomas Hochland Brokenveld
- Urban semi-natural/unnatural

Most of the study area can be classified as the Khomas Hochland broken veld with rolling steep hills and mountains surrounded by the urban semi-natural and unnatural habitats. Other habitats that are also prominent are the relatively flat Windhoek Valley section on the north and south of the city, as well as the high mountains habitat in the Auas and Eros mountains to the south of the City (City of Windhoek, 2004: 67). It can be said that Windhoek has a rich biodiversity that deserves protection. The urban, semi-natural/unnatural habitat is elaborated on below.

4.2.5.1 Urban semi natural/unnatural

These habitats consist of the open spaces and development altered areas in the urban areas with the remains of vegetation such as sport fields, parks, cemeteries, urban gardens and sewage works. The urban-unnatural provide resources to unwanted animals. These areas include burrow pits, degraded land, denuded veld due to topsoil stripping. The threats in the urban-unnatural areas include urban sprawl that is usually associated with habitat destruction and alien invasive vegetation that is introduced into gardens and this can lead to an improvised food web. Moreover, this improvised food web can introduce pests. Also, the threats include habitat alteration by gardening with non-indigenous plants that can lead to the lack of a suitable habitat for certain tree dwelling reptiles and small animals. Similarly, diseases from dogs, such as rabies, can be transmitted to indigenous fauna. Also, traffic can result in animals being killed while crossing the roads, i.e. amphibians, reptiles and small mammals. In addition, electric fences erected to protect properties pose a threat to chameleon, tortoises, snakes and lizards. Another threat is the illegal collection of high valued endemic reptile species

for export purposes. Lastly, light and noise pollution can negatively affect the occurrence of some species (City of Windhoek, 2008a: 47).

In the semi-natural urban habitats, such as recreational areas, threats can include waste from park users and dung from pets that attract creatures such as flies, ants and dung beetles. The removal of natural refuse, such as fallen leaves, can destroy the natural habitat of several smaller anthropods as these organisms are natural recyclers, thus the removal or their food and habitat resources may eliminate the organisms. Moreover, natural vegetation is placed under stress when alien vegetation is introduced because they naturally compete for water and nutrients. Lastly, the loss of connectivity when the green corridors in natural areas are non-existent may result in unviable populations of species trapped within these areas (City of Windhoek, 2008a: 47-48).

4.3 Social environment

4.3.1 Population

According to the last census that was done in Namibia, the Namibia 2011 Census report, the urban population had increased by 49% whilst the rural population decreased by 1.4% between 2001 and 2011, demonstrating the high rate of rural-urban migration in Namibia. In the Khomas region, where Windhoek is located, there is an increase in the population of 36.7%. Moreover, the Khomas region alone accommodates 16% of the total population of Namibia. The total number of people living in Windhoek was estimated at 325 858 during 2011 whilst with the previous census in 2001, the total was only 233 529, depicting a remarkable 39.5% increase in the population size (GRN, 2011a: 37-39).

Based on the information on the population projections in Table 4.1, it is likely that the increase in population is most likely to continue due to the rural-urban migration.

Table 4.1: Population projections for the City of Windhoek (Windhoek Structure Plan: 1996).

Year	High Projection	Low Projection
1995	182 000	182 000
1996	192 000	192 000
2000	241 000	237 000
2005	318 000	307 000
2010	421 000	393 000
2015	558 000	498 000
2020	740 000	623 000

Some 600 people moved into Windhoek each month between 1991 and 1995 and it is expected that the population in Windhoek will double every 12 to 13 years. It is estimated that around 75-85% of Namibians will be living in towns by 2020, if this rate of urbanisation is to remain (Mendelsohn *et al*., 2002: 163; Bäumle *et al*., 2011: 163).

During 2016, the City of Windhoek indicated that the population of Windhoek was some 440 000 and the population growth was estimated at 4,4%. It was also pointed out that Windhoek was in the top five SADC capital cities in terms of cost of living, crime awareness and the availability of social services. Windhoek is also one of the few African cities that has its own police force (City of Windhoek, 2016).

The Windhoek SEA indicated that in 2009 about 100 000, or 30%, of residents in Windhoek lived in informal settlements. It was then estimated that by 2016, the number of residents living in informal settlements in Windhoek would be around 200 000 and would make up 50% of the population of Windhoek. Also, the rapid population growth in Windhoek was said to be due to large-scale migration of poorer people from rural areas. Moreover, it was indicated that the population growth is likely to increase the pressure on the City's natural and human resources. The resources to be affected were described as water, land, public open spaces and natural ecosystems. The human systems to be affected are the housing, with specific reference to the informal and low-income housing, as well as the municipal services and infrastructure. It was said that the failure of the City to meet the needs of the growing population in terms of the

provision of basic services, would lead to more informal settlements and residents with inadequate access to essential services (City of Windhoek, 2011: 13-14).

Poverty is an environmental concern on its own because it negatively impacts on the environment as the livelihoods of the poor depend on the environment (Hasheela, 2009: 53-54).

4.4 Economic environment

4.4.1 Poverty and unemployment

Inequality in Namibia dates back to the mid-1990s when it was regarded as the country with the highest inequality levels. In a Government report released in 2008, but based on information gathered in 2004, Namibia was still rated as one of the most unequal countries in the world (Jauch, 2012).

The relatively stable political environment in Namibia, coupled with good economic management, have assisted with a stable economic growth and the reduction of poverty in the country. Between 2011 and 2015 the economy in Namibia grew at an average annual rate of 5.6% per annum. The growth was due to large investments in "extractive projects, strong export prices, rapid private credit growth and a programme of deficit-financed fiscal stimulus". The economic development, however, did not give rise to job creation, and social and economic inequalities inherited from apartheid are still prevailing, regardless of substantial investment into social programmes. Moreover, Namibia is exposed to "short- and long-term environmental shocks" due to the country's dependence on the fragile ecosystem (The World Bank, 2017).

The Government of Namibia, through the National Planning Commission, conducted the third Household Income and Expenditure survey in 2015/2016 since Namibian Independence in 1990. The preliminary report indicated that the method used to define poor was that if a person was not able to spend at least N$ 389.30 per month on basic necessities, they were considered severely poor, and if a person was not able to spend at least N$ 520.80 per month on basic needs, such a person was considered poor. Thus, the preliminary report indicated that poverty decreased during the past five years, in

that 132 282 persons could still not afford to buy the minimum food (2100 Kcal) per day and that 11% were still below the lower bound poverty line while 18 % of the population are below the upper bound poverty line. Also, it was indicated that the inequality in income distribution was very high. The most populated region in Namibia is still the Khomas Region (Namibia Statistics Agency, 2016: 11-13).

According to the 2008 Labour Force Survey of Namibia, of which Windhoek is part of, a person is employed when that person has worked for remuneration, profit or family gain for at least one hour during the 7 days prior to the survey interview. Moreover, the Government of Namibia based its unemployment definition on three criteria namely: being without work, being available for work and seeking work. Thus, the unemployment definition in Namibia excludes individuals between the ages of 15-65 that are without jobs and are not actively seeking employment, although the broader definition of unemployment regards a person between the age of 15-65 without a job unemployed whether that person is seeking employment or not (Jauch, 2012).

Unemployment performance in Namibia has been deteriorating from as early as the 1980's, although there was a slight improvement in the 1990s. However, during the past three decades, the unemployment rate has increased. In 2008, the unemployment rate reached 37.6% (Sunde & Akanbi, 2016: 126). Unemployment in the Khomas region is likely to continue to grow with the current urbanisation of unemployed people immigrating to Windhoek (City of Windhoek, 2011: 15). A clear line between unemployment and education can thus be drawn (Jauch, 2012).

4.4.2 Education

According to the Windhoek Strategic Environmental Assessment, in instances where the head of a household has a low education, they are likely to be in a lower economic category as well (City of Windhoek, 2011: 15).

The Namibian 2011 population and census main report shows that the majority of people that never attended any school live in the rural areas. This is 17.6%, whilst only 7 % of the people residing in the urban areas did not receive schooling. In the Khomas

region 89.6% of children aged between 7-13 years enrolled for primary school (GRN, 2011a: 50-51).

The City of Windhoek SEA of 2011 indicated that the rapidly growing population in the city is placing education facilities under immense pressure, especially in the lower income areas and it was projected that the shortage of education will be intensified should the population in Windhoek continue to increase (City of Windhoek, 2011:15). Namibia is known as a country that invests in its education system. However, the output of the education system and its role in poverty reduction remains uncertain (Goamab, 2005).

The Khomas Region, especially Windhoek, was experiencing major challenges. It was indicated that the Ministry of Education was aware of the problem and had over the past 20 years constructed some primary and secondary schools to accommodate all school age children. Also, due to the unprecedented rapid pace and massive volumes of children that needed accommodation in schools, the government also established project schools over the past five years. These project schools accommodate learners in temporary tents and sometimes semi-permanent structures (New Era, 2015).

4.4.3 Tourism

Tourism is the fastest growing economic sector globally and this also applies to the Namibia Tourism sector that showed an increase of 8-10% annually during the past decade. Moreover, the tourism sector in Namibia is dependent on the natural environment (Bäumle *et al.*, 2011: 154).

Tourism in Namibia increased in 2016 as there was a rise in the number of visitor arrivals and rooms sold. The number of visitor arrivals coupled with the number of rooms and bed nights sold, is a strong indicator of tourism. This increase was estimated at 5.9% (BON, 2016: 128).

In Namibia, almost 14.1% of Namibia's surface area is made up of nature reserves and national park land. In addition, numerous private farmland, as well as communal land, have been declared as conservation areas. In some communal land the natural resources

are not only protected, but also utilised to benefit the conservancy members that live in the area. Most of the conservation land is used for tourism in Namibia. (Mendelsohn *et al.*, 2002: 154).

Many tourists enter Namibia through the Hosea Kutako International Airport near Windhoek. It can therefore be said that Windhoek is a gateway to other tourism destinations in Namibia. Numerous tourists stay over in Windhoek. Windhoek boasts a blend of African and European cultures and is said to be one of the neatest capital cities in Africa. Moreover, Windhoek offers modern, world class amenities such as hotels, banks, posts offices, gyms, libraries, museums and car rental companies (City of Windhoek, 2017b). Windhoek has several cultural historical features (City of Windhoek, 2004: 157) that are attractive to tourists. Some of the top attractions in Windhoek are the Heroes' Acre, the Old Prison in Goethe street, the Turnhalle Building, Tintenpalast and the Elizabeth House. Also, there are numerous historical cemeteries in Windhoek where many German soldiers who perished during the Nama and Herero Wars were laid to rest. Also, the graves of the German officials, settlers, civilians and the Witbooi troops can be found in the historical cemeteries. In addition, the Old Location cemetery houses a mass grave of those who were shot at and fatally wounded on 10 December 1959 when refusing forced removal from the old location (City of Windhoek, 2017c).

4.5 Political environment

The new Constitution of Namibia established a three-tier system of governance namely, "central government, regional councils and local authorities". Moreover, important services such as health, education and agriculture were centralised under line ministries. The second tier encompasses the regional councils accountable for service delivery in rural areas. The third tier is made up of the local authorities, which are in control of service delivery in urban areas. Through proclamation, the local authorities become independent bodies under the general supervision and guidance of the Ministry of Local Government and Housing. Local authorities carry out functions according to "Section 3(2) of the Local Government Act No.23 of 1992 as amended by the Local Authorities Act No. 17 of 2002" (Fjeldstad, Geisler, Nangulah, Nygaard, Pomuti, Shifotoka & Van

Rooy, 2005: 6-8). The Act differentiates between municipalities, towns and villages with municipalities being the highest and most independent type of local authority. Moreover, municipalities are classified into Part 1 and Part 2 municipalities, Part 1 being financially solid and independent and able to make decisions regarding property taxes and acquiring loans, while Part 2 municipalities are not financially independent and are controlled by the Ministry of Local Government and Housing with regard to setting property taxes and obtaining credit facilities. Namibia currently has three Part 1 municipalities, of which Windhoek is one.

The "Mayor of Windhoek is the political head of Council and its Chairperson". The councillors are elected and have no executive powers, they perform their duties on a part-time basis. Moreover, the Mayor is assisted by five Management Committee members. The Mayor is also assisted by the Chief Executive Officer (CEO). The daily administration of the Office of the Mayor falls under the Office of the CEO (City of Windhoek, 2017a).

4.6 Built environment

4.6.1 Lack of formal housing

Windhoek is the largest urban centre in Namibia and in 2001 already housed 39% of the urban population tailed by Walvis Bay at 7.2%. Moreover, it is estimated that 40% of the urban population in Namibia live in informal settlements. Access to housing remains a problem and urban migration is expected to place an extra financial burden on municipalities as the lack of government subsidies will result in municipalities having to bear the costs. These municipalities will have to use internal resources to develop poor informal areas by making provision for infrastructure and provision of basic services (Fjeldstad *et al.*, 2005: 14). The State of Environment Report of May 2008 stated that at least 24.13% of all housing structures in Windhoek are improvised houses being corrugated iron shacks or improvised shacks (City of Windhoek, 2011: 16).

The 2001 Census report indicated that at least 100 000 people in Windhoek live in informal settlements. This is about 30-40% of the residents in Windhoek and the

population growth rate of people living in informal settlements is estimated at 9.5% per annum. These informal settlements are located on the periphery of the city where land is inexpensive and continues to expand into the mountains. These people live in extreme poverty. Moreover, most of the improvised houses lack basic services such as electricity, running water or toilets (Ishimael, 2016: 2-25).

The Namibian National Housing policy of 1991 is based on the co-operation between the "public, semi-public, and private sectors, with the government". The government mainly plays the role of a facilitator. The policy emphasises community participation throughout the planning, design and implementation of the housing policy. Moreover, the provision of affordable serviced land, with a secure tenure for low-income households, is part of the National Housing Plan. Also, the policy makes provision for local authorities to set aside land for new migrants to build temporary structures for improvement at a later stage. Municipalities are discouraged from forcing residents out of informal settlements and should rather assist with the upgrading of the informal settlements. However, the policy mostly failed during the 1990's as large-scale invasion of land occurred prior to the sites being allocated and growth could therefore not be contained within the boundaries of the areas that were set aside. Similarly, in 1992, the National Housing Programme, "Build together' commenced. Poorer residents were afforded the opportunity to build houses according to their needs and available resources. The Build together programme was centralised to local councils. The programme required that applicants have a formal income of not more than N$2000 per month. Moreover, the houses were built using informal and family labour and subsequently the construction costs were approximately 40% less than houses constructed by contractors in the formal sector. The houses were built in formalised areas, on land leased by council and the designs always included a connection to water, sewerage and electricity. Numerous problems were experienced with the Build together programme such as loans that were not repaid and houses that were not completed although funds and building materials were issued. Also, many poor people struggled to obtain loans from the Build together programme because the number of applicants far exceeded the successful applicants. Consequently, the National Housing Action Group (NHAG) and its partner the Shack Dwellers Federation of Namibia (SDFN) lobbied for land for those poor people that did not qualify for Build together loans. Also, the SDFN tried to prepare the members to take up loans by encouraging the

people to save money on a group administered bank account. Basically, proving that you could save money was the only requirement by the SDFN to obtain a loan. The SDFN is also involved in negotiating plots for their members (Fjeldstad *et al.*, 2005: 18-21).

4.6.2 Water, sanitation and electricity

In the Khomas Region, there are no households that are dependent on flowing or stagnant open water as their main source of water. Also, the 1991 Population census reported that 7% of households in the Khomas region had to use the bush as toilets. Safe sanitation includes flush toilets, chemical toilets and ventilated pit latrines. Moreover, in some of the poorer areas in Windhoek the percentage of people that use the bush as a toilet were significantly high being 50.6% in the Moses Garoeb-, 22.5% in the Samora Machel – and 57.6% in the Tobias Hanyeko constituency. This high rate is a cause of concern and is expected to increase as the population in the informal housing sector increases. Also, access to electricity can pose a burden on the environment, as well as human health. Poor people use wood, paraffin or coal as energy for cooking and heating. The use of wood results in a loss of natural vegetation and deforestation in the surrounding areas. In addition, the fumes generated from burning coal and paraffin have a negative impact on human health when inhaled. In 1993 the Namibia Household Income and Expenditure Survey found that 6% of Windhoek households did not have access to electricity for cooking. This number escalated as the 2001 Population and Housing census indicated that 8.8% of all households in the Khomas Region used wood or charcoal from wood for cooking, whilst 17.1% used paraffin. Moreover, in the poorer areas of Windhoek 10.2% of households in the Moses Garoeb constituency and 12.9% in the Tobias Hainyeko Constituency used wood or charcoal from wood for cooking. Thereafter the 2003/2004 Namibia Household Income and Expenditure Survey indicated that 25.5% of all households in the Khomas Region prepare food without the use of electricity, gas or solar energy. There has been a remarkable increase in households who did not have access to electricity (City of Windhoek, 2011: 16-19). The main reason for not providing sufficient infrastructure in Windhoek was a lack of funds (City of Windhoek, 1996).

4.6.3 Solid waste management

The City of Windhoek has a well-run and efficient waste management system. The Kuferberg Landfill Site is used for the disposal of household waste. Also, the Kupferberg Landfill site had a lined hazardous waste cell for the disposal of hazardous waste. The lifespan of the Kupferberg Landfill site is estimated between 10-15 years. Other smaller landfill sites for the disposal of garden refuse and building refuse are located in different locations in Windhoek. The lifespan of the smaller landfill sites ranges between 8-10 years with only the Havanna Landfill site with an estimated lifespan of 10-15 years. The average lifespan of landfill sites in Windhoek is estimated at 10 years (City of Windhoek, 2011: 20-21).

4.6.4 Transport

Many residents in Windhoek do not have their own transport or cannot afford to buy their own vehicles. Public transport in Windhoek is mainly made up of taxi's and bus services. Also, the travel distances are increasing and coupled to this is the increase in traffic congestion (City of Windhoek, 1996).

The City of Windhoek has an extensive road network of 812km with a good road surface, except for a few gravel roads in the informal settlements. There is, however, almost no provision made for pedestrians and cyclists. Also, there are not clear bus lanes in the road reserve, although there are already 160 bus stops along the entire City of Windhoek bus network. In addition, a total of 48% of the bus stops do not have a bus shelter for the clients. The bus services run by the City of Windhoek only operate from Monday to Friday. The current charge is N$ 5 per trip if a Smart card is bought at one of the City of Windhoek sales points and it should be paid for in cash – the cost is N$6. The fare is considered high when compared to other cities in Africa. There is a total of 79 buses servicing Windhoek of which 55 are old and unreliable (Heidersbach & Strompen, 2013: 30-31).

The City of Windhoek, having realised that transport affects the daily lives of residents in different ways, will now investigate new approaches to ensure efficient and coordinated sustainable urban transport in Windhoek. According to the new transformational strategic plan of the City of Windhoek, seven new modern bus lines

will be introduced. Also, more buses will be procured to improve the capacity and quality of the bus service delivered (City of Windhoek, 2017d: 52).

The taxi transport system dominates the transport services in Windhoek and surrounding areas. There are 295 taxi ranks in Windhoek. Most of the taxi ranks are in the low and middle-income areas where car ownership is low. Also, the taxi industry is regulated by the Ministry of Works and Transport and the City of Windhoek. Problems with unregistered taxi's exist and the level of organisation and transparency in the taxi industry is low. The different registered organisations in the taxi industry are the Namibian Bus and Taxi Organisation (NABTA) that is a taxi owner's organisation and employer's federation. Then, there is also the NTTU, that represents all drivers in the transport industry. Lastly, the most recent established organisation is the Namibia Public Passenger Transport Association (NPPTA). There is still some dissatisfaction among the users of the taxi's. The users herald the opinion that there needs to be a body at which to lay complaints against taxi's (Heidersbach & Strompen, 2013: 34-35).

Non-motorised transport is used at minimum in Windhoek, due to the lack of infrastructure. There is a lack of walkways and bicycle lanes. The lack of uninterrupted pathways and cycling routes lead to accidents when the non-motorised transport users use the streets. Many times, these accidents are fatal. Therefore, many pedestrians use the riverbeds although the pathways are not paved. Also, the pedestrians expose themselves to crime in the riverbeds. Major cycling events are held in Windhoek, that are sponsored by corporates and banks. Also, numerous private and non-governmental initiatives exist that promote cycling for recreational and commuter purposes. In 2012, only 2 % of the City of Windhoek budget was spent on non-motorised transport facilities (Heidersbach & Strompen, 2013: 36-39).

The City of Windhoek has a new Non-Motorised Transport (NMT) strategy which aims to change individual travel behaviour in favour of more sustainable options. The NMT strategy will be implemented over the next five years and will include pedestrian paths, cycle ways, signage and intersection improvements (City of Windhoek, 2017: 51).

4.7 Summary

This chapter looked at sustainability in Windhoek based on the five pillars of sustainability. In the biophysical environment, Windhoek is located centrally in Namibia. Namibia is one of the driest countries in the world. The City exists in what is referred to as a basin, surrounded by mountains. Moreover, in the foothills of the mountains, quartzite stone is found that contributes to the infiltration of water, giving rise to the main Windhoek aquifer. Ground water is an important source of water in Windhoek, due to the lack of perennial rivers in central Namibia. There are three constructed dams that supply water to Windhoek. Also, water has been reclaimed in a reclamation plant from sewerage water since 1968. The topsoil in Windhoek is generally relatively thin and prone to erosion. The biodiversity in Windhoek is divided into six habitats, each with its own plant and animal life. Various threats to each habitat have also been identified.

In the social environment, Windhoek's population has come under intense scrutiny. There has been a major increase in the size of the population in Windhoek since Independence in 1990, due to urbanisation. This increase in population together with the shortage of formal housing has brought severe pressure on natural and human resources.

In the economic environment, with regards to poverty and unemployment, Namibia is also rated one of the most unequal countries in the world. The unemployment rate increased during the past three decades and 11% of people in the country are below the lower bound poverty line and cannot afford to buy the daily minimum basic nutritional needs. Moreover, education and poverty could be linked in that there was a lower economic standard in households where the head of the households had a lower education level. Also, the increase in population in Windhoek has placed educational facilities under pressure. However, tourism in Namibia has increased, as numerous tourism attractions are found in Windhoek.

The political environment is well structured under the three-tier system in the government of Namibia. Local Authorities operate according to the Local Authorities Act, 23 of 1992. The City of Windhoek is a Part 1 municipality and can control its own

finances, makes decisions on property taxes and is able to acquire loans without outside inteference. The City of Windhoek is run by a municipal council, supported by an administrative body.

Under the built environment, the lack of formal housing, supply of water, sanitation and electricity, solid waste management and transportation were discussed. There are 30-40% of the residents in Windhoek living in informal structures. Various policies are in place in an effort to overcome this problem. There is also a lack of water, sanitation and electricity to many of these informal structures in the informal settlements. Moreover, there is a fixed disposal site for household refuse. Also, various smaller refuse sites are located all over Windhoek for the disposal of garden and building rubble. Transport in Windhoek is dominated by motorised transport. Many residents own their own cars. The residents that do not have their own transport make use of municipal busses and mainly taxis. The non-motorised transport section is experiencing problems due to the lack of infrastructure. Walkways and cycle lanes to accommodate pedestrians and cyclists are only found in a few streets in Windhoek. In fact, there is a need for an uninterrupted network of walkways and cycle lanes all over Windhoek to strengthen this sustainable way of travelling.

CHAPTER 5: POLICY AND LEGAL FRAMEWORK FOR SUSTAINABILITY AND RESILIENCE IN NAMIBIA AND WINDHOEK

5.1 Introduction

In Chapter 5, the sustainability in Windhoek, based on five pillars of sustainability namely the biophysical environment, social environment, economic environment, political environment and the built environment was reviewed. It was found that Windhoek is situated in one of the driest counties in the world. Also, as Windhoek is the capital city of Namibia, urbanisation is bringing about major challenges such as a lack of formal housing and pressure is being heaped on the natural environment and human resources. Moreover, there is a high unemployment rate and poverty is rife. There is a lack of infrastructure to provide basic services in informal settlements in Windhoek.

Namibia gained Independence in 1990 and thereafter much environmental legislation was put in place to protect the environment and ensure sustainable development. In this chapter, the institutional arrangements with respect to sustainability and resilience of the Namibian national and local authority policies and plans will be discussed.

5.2 The Namibian Constitution of 1990

The Namibian Constitution is the foundation of all other policies and legislation in Namibia It makes provision for three key environmental clauses pertaining to the sustainable use of natural resources in Namibia (Ruppel, 2016a: 31). The three clauses are as follows:

i. Article 100 states that all natural resources belong to the state unless otherwise privately owned. Private ownership of natural resources should be legally proven. It reads as follows:

Land, water and natural resources below and above the surface of the land and in the continental shelf and within the territorial waters and the

exclusive economic zone of Namibia shall belong to the State if they are not otherwise lawfully owned". (GRN, 1998a).

ii. Article 95 (l) indicates that the state shall at all times maintain and promote the welfare of the people by adopting policies that will ensure the

"…maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future; in particular, the Government shall provide measures against the dumping or recycling of foreign nuclear and toxic waste on Namibian territory" (GRN, 1998a).

iii. Article 91(c) stipulates that one of the duties of the Ombudsman is to investigate environmental complaints. The article includes the following:

"…the duty to investigate complaints concerning the over-utilization of living natural resources, the irrational exploitation of non-renewable resources, the degradation and destruction of ecosystems and failure to protect the beauty and character of Namibia…" (GRN, 1998a).

The Namibian Constitution therefore stipulates the importance of the sustainability of non-renewable resources and over-utilisation of living natural resources. Also, the Constitution emphasises the protection of ecosystems and the protection of the aesthetical values of the country. In addition, the importance of conservation "for the benefit of present and future generations" is emphasised. Moreover, the Namibian Constitution stipulates that policies be put in place to achieve these goals put down by the Constitution. The Namibians also have the right to complain about environmental mismanagement through the Ombudsman.

5.3 Namibia's Green Plan of 1992

Namibia's Green Plan was formulated by the Ministry of Wildlife, Conservation and Tourism together with governmental and non-governmental institutions and was first presented at the Rio Conference in 1992. The aim of the Green Plan is to secure a "safe and healthy environment and a prosperous economy for present and future

generations". It recognises that the health of individuals, the community and economy is connected to the health of the environment. Also, it emphasises the precautionary principle, and that large construction projects, particularly where large amounts of water are concerned, should be preceded by an Environmental Impact Assessment. The Green Plan gave rise to the Environmental Management Act, the Environmental Impact Assessments, Strategic Environmental Assessment, Integrated Regional Land Use Plans, Community-based Natural Resource Management and the Environmental Investment Fund (Ruppel, 2016a: 31-32), after it had led to the 12-point plan for Integrated and Sustainable Environmental Management in 1993, to handle present environmental concerns, as well as to prepare Namibia for future environmental issues (Brown, 1993: 2-4).

5.4 Vision 2030

Namibia's Vision 2030 was launched by the founding president Dr. Sam Nujoma in 2004. The goal of this national vision is to "improve the quality of life of people in Namibia" and up the level of people in the developed parts of the world. Moreover, sustainable development is crucial for Vision 2030 as it cuts across all sectors (GRN, 2004: 9-14). It provides a framework for the design of broad long-term strategies for national development for implementation through the National Development Plan, as well as their medium-term plans and budgets. The five-yearly planning cycles, already in use, will provide a foundation for the monitoring and evaluation of the objectives of Vision 2030 (GRN, 2004: 15-22). According to Ruppel (2016a: 32) the foundation of Vision 2030, is to "provide long-term policy scenarios on the future course of development in the country at different points in time up until the target year of 2030".

Vision 2030 addresses the sustainable use of water and recognises that "water is an extremely scarce resource in Namibia" and that the lack of freshwater in especially central Namibia is limiting development. It is also recognised that the water demand will increase over the next 30 years, particularly in the central areas. Therefore, one of the sub-visions is to ensure that "Namibia's freshwater resources are kept free from pollution and are used to ensure social well-being, support economic development, and to maintain natural habitats" (GRN, 2004: 136-137). Moreover, Vision 2030

acknowledges that an enabling environment is necessary to attain sustainable development and therefore one of the aims is also to strive for the formation and upkeep of such an environment in Namibia – one that will ensure peace and stability, and progress in development (GRN, 2004: 174-177).

5.5 National Development Plans

5.5.1 NDP1

Namibia has since Independence used planning as a management tool and started with the NDP1 which spanned the years from 1995-2000 (GRN, 2004: 38). Its main focus was to formulate a medium-term development programme and diversify the economy, linking the achievements during the first five years of Independence (GRN, 2017a). Moreover, NDP1 was also central in the Namibia's National Resource Sector Strategy which was one of eight thematic studies that, when combined, would form Namibia's Vision 2030. In addition, Namibia's Green Plan and NDP 2 also played a vital part in promoting sustainable development in Vision 2030 as an effort was made to include environmental and sustainable development goals in NDP2 after the goals were set out in Namibia's Green Plan (GRN, 2001: 2).

5.5.2 NDP2

NDP2 spanned the years 2001/2 to 2005/6 (Ruppel, 2016a: 32-33) with the acknowledgement that economic growth was coupled to natural resources and its unique environment, environmental and sustainability aspects in sectoral, cross-sectoral and regional development planning were considered. The NDP2 was also more consultative with a wider group of participants. It differed from the NDP1 in that cross-sectoral policies were presented, and included a volume with regional development issues and new topics such as "poverty reduction, income distribution, HIV/AIDS, science and technology, private sector development, etc.". These new topics were included to enlarge and strengthen the focus and trusts of the NDP2 (GRN, 2017b). It was responsible for the finalisation of numerous acts that contributed towards limiting and/or mitigating adverse environmental impacts of developments, such as the Environmental Management Act, the Integrated Pollution Control and Water

Management Act, the Environmental Investment Fund Act and the new Wildlife and National Parks Act. (GRN, 2008: 20).

5.5.3 NDP3

The NDP 3 spanned the five years from 2007/8 to 2011/2 and the aim was to accelerate economic growth through environmental conservation (Ruppel, 2016a: 33). A total of N$76,3 billion was required from "public, private and international stakeholders" to realise the NDP3 targets and to attain the average growth rate of 5% per annum. The initial investment for NDP2 was N$55.3 billion with an average growth of 4.7% (GRN, 2017c). One of the key result areas of the NDP3 was the sustainable utilisation of natural resources and environmental sustainability, from the Vision 2030 objective which was aimed at developing "Namibia's natural capital and its sustainable utilisation for the benefit of the country's social, economic and ecological well-being". In turn, this Vision 2030 objective is aligned to the Millennium Development Goal 7 for safeguarding environmental sustainability (GRN, 2008: 106).

5.5.4 NDP4

The NDP4 was released in July 2012 and spans 2012/13 to 2016/2017 (GRN, 2017d & Ruppel, 2016a: 33). The NDP4 differed from the preceding plans in that there were fewer, cautiously selected and sequenced goals with linked target values, and detailed programmes giving guidelines on how to attain the goals and to be directed to the different offices, ministries and agencies. The logistics, tourism, manufacturing and agriculture sectors were prioritised. Implementation strategies had a special focus on monitoring and evaluation (GRN, 2017d). However, environmental sustainability and the sustainable utilisation of renewable and non-renewable resources that were part of the goals of NDP3, did not form part of the NDP4 (Ruppel, 2016a: 33), though mentioned in the background. It stated that society and businesses should support the precautionary approach to environmental challenges and changes in the environment due to climate change, and that people should be encouraged to be accountable for their own growth and promote development activities that attend to their needs (GRN, 2012a: 4-5).

5.5.5 NDP5

Namibia's 5th National Development Plan (NDP5) was planned to be implemented in the financial years 2017/18 up until 2021/22. It lists challenges to be transformed into opportunities, including that the Namibian ecosystem is fragile and vulnerable to shock, but also an opportunity for the extraordinary beauty and wildlife to attract tourists from all over the world (GRN, 2017e: 3-4).

The four pillars of the NDP5 are "economic progression, social transformation, environmental sustainability and good governance". These pillars are in accordance with Namibia's pledge to fight poverty and inequality as described in Vision 2030, the Harambee plan of 2016 and the SWAPO party Manifesto of 2014. Also, these pillars are aligned with global and continental development plans including Agenda 2030, Sustainable Development goals, the Paris Agreement (CoP21), the African Union Agenda 2063 and the SADC Regional Indicative Strategic Development Plan (GRN, 2017e: 7).

5.5.6 Harambee Prosperity Plan (HPP) of 2016/17 – 2019/20

In addition to the NDPs, Namibia launched a targeted action plan, namely the Harambee Prosperity Plan (HPP) to fast-track development in specified targeted areas, which are fundamental to attaining prosperity in Namibia, to complement the NDPs and Vision 2030. Additionally, the Harambee Plan also incorporated new development opportunities and it addressed new plans that came forth after the NDPs were formulated (GRN, 2016: 6).

5.5.7 Namibia 2013 Millennium Development Goals Report (MDGR)

The Millennium Development Goals (MDGs) of Namibia form an important part of the global vision of a "well-nourished, skilled, healthy populace, pursuing and sharing prosperity and wealth-creation in an equitable and environmentally sustainable manner". The Millennium Development Goals (MDGs) of Namibia are as follows:

"MDG 1: Eradicate extreme poverty and hunger

MDG 2: Achieve universal primary education

MDG 3: Promote gender equality and empower women

MDG 4: Reduce child mortality

MDG 5: Improve maternal health

MDG 6: Combat HIV and AIDS, malaria and other diseases

MDG 7: Ensure environmental sustainability

MDG 8: Develop a global partnership for development"

The MDG Report elaborated on the progress made with regard to the development goals for Namibia. There are still goals that were not attained such as the equitable distribution of income, or eradication of hunger, the survival rate of primary learners to Grade 8 level, reduction in child mortality rates, the target of halving the proportion of people without access to basic sanitation, secure land tenure for poor people and optimal progress in global partnership development (GRN, 2013a: 9-13).

5.6 Environmental Management Act 7 of 2007

The Environmental Management Act 7 of 2007 (EMA) is an essential instrument to ensure environmental protection in Namibia. It stipulates that the principle of sustainable yield be adhered to in the use of all-natural resources and gives meaning to Article 95(l) of the Constitution which stipulates that policies should be developed and implemented to protect the environment and utilise resources in a sustainable manner. Moreover, it encourages the coordinated and integrated management of the environment and indicates the different responsibilities thereof. The EMA gives constitutional effect to the Environmental Assessment Policy, it empowers the Minister of Environment to lend effect to Namibia's commitments under international environmental conventions and further, makes provision for related matters (Ruppel, 2016a: 42).

The EMA promotes community participation and involvement in natural resources and it is further stipulated that should benefits arise from the use of the resources, the community should also share in these benefits. Most importantly, however, it is stipulated that "sustainable development be promoted in all aspects relating to the environment".

Part IV of the EMA orders the establishment of a Sustainable Development Advisory Council (SDAC), to promote co-operation and co-ordination between different role

players in the government, as well as the private sector. In addition, the Advisory Council would advise the Minister on the development of policy and strategy relating to the protection of the environment and the conservation of the biodiversity, and the sustainable use of the environment (GRN, 2012b: 9).

The EMA also makes provision for the appointment of an Environmental Commissioner to advise different organs of the state on the preparation of environmental plans, manage applications and approvals for environmental clearance certificates and monitoring of compliance in terms of the act (GRN, 2012b: 13).

Moreover, the EMA stipulates that environmental plans be submitted by organs of the state to enable the Minister to monitor the achievement, promotion and protection of a sustainable environment (GRN, 2012b:18). It requires an environmental clearance certificate for activities listed by the Minister in the *Gazette,* which s stipulates that an Environmental Assessment be submitted to the Environmental Commissioner for a review and decision (GRN, 2012b: 22-25). The Environmental Impact Assessment (EIA) regulations followed and were *gazetted* in 2012 (GRN, 2012c: 1).

5.7 The National Policy on climate change for Namibia of 2011

Namibia is highly dependent on its natural resources for economic growth, and adverse impacts will negatively affect the economy and sustainable development. Various uncertainties exist in the accurate detection of future climate change scenarios, but an increase in temperature and evapo-transpiration is expected, particularly in the interior. Moreover, climate models in the Initial National Communication (INC) report of 2002, predicted that the mean annual temperature for Namibia would increase by 2 to 6°C by 2100. Also, the Global Circulation Models (GCMs) indicate that rainfall reductions of 10% to 30% are predicted for Namibia, with an evaporation increase of about 5% (GRN, 2010: 2-6).

The National Policy on Climate change for Namibia launched in 2011 provides a framework on climate risk management to assist Namibia in attaining sustainable development in line with Vision 2030, by strengthening capacities, reducing the risks

associated with climate change and to build resilience against climate change shocks (Ruppel, 2016a: 40).

Climate change coupled with land-use change, degradation of ecosystems, poverty and inequality is one of the factors that inhibits resilience (Ruppel, 2016b: 289).

5.8 National Climate Change Strategy and Action Plan of Namibia of 2013-2020

The National Climate Change Strategy and Action Plan of Namibia (NCCSAP) was developed to implement the NPCC and curb negative climate change impacts that may negatively affect the targets of Namibia's Vision 2030 (GRN, 2013b: 13). The main aim of the NCCSAP is to build Namibia's adaptive and mitigative capacities by identifying different adaptation options and explore developmental action with mitigation actions in order to guide the country onto a low-carbon development pathway. The NCCSAP identifies focus areas for adaptation and mitigation, as well as cross-cutting issues concerning adaptation and mitigation in Namibia (GRN, 2013b: 30-33).

5.9 The National Disaster Risk Management Policy of 2009

Article 26 of the Constitution of the Republic of Namibia assigns primary responsibility for disaster risk management to Government. The National Disaster Risk Management Policy pursues this obligation. It aims "to contribute to the attainment of sustainable development in line with Namibia's Vision 2030 through strengthening of national capacities to reduce risk and build community resilience to disasters". Its approach involves regarding disasters as serious occurrences and should not only be managed by emergency and support services. This requires a significantly improved capacity for early warning and for tracking, monitoring and disseminating information on phenomena and activities that trigger disaster events.

The policy looks at "existing coping mechanisms of vulnerable communities, households and individuals by advocating the enhancement of coping capacities in the affected communities. It also calls for improved institutional emergency preparedness

and response capacity at local, regional and national levels and implies an increased commitment to strategies to prevent disasters and mitigate their severity". For its hazard profile, it identified the following hazards:

- The drought phenomenon,
- Flooding,
- Epidemics (human health),
- Climate change,
- Environmental degradation,
- Livestock epidemics,
- Forest and veld fires,
- Road and rail traffic accidents.

Its policy objectives are consistent with the priorities for action identified in the Hyogo Framework for Action 2005-2015, and the Sendai Framework for Disaster Risk Reduction (2015-2030), to which Namibia was party. The objectives are as follows (GRN, 2012d):

i. *Make disaster risk reduction a priority at all levels in Namibia by establishing sound, integrated, and functional legal and institutional capacity within the established National Disaster Risk Management System, to enable the effective application of the concept of total disaster risk management.*
ii. *Improve risk identification, assessment and monitoring mechanisms in Namibia.*
iii. *Reduce the underlying risk and vulnerability factors by improving disaster risk management applications at all levels.*
iv. *Strengthen disaster preparedness for effective response and recovery practices at all levels.*
v. *Enhance information and knowledge management for disaster risk management"* (GRN, 2012d).

5.10 Disaster Risk Management Act, 2012 (Act No. 10 of 2012)

The purpose of the Disaster Management Act of 2012 is to give effect to the National Disaster Risk Management Policy and provide for the formation of establishments for

disaster risk management in Namibia. It must also provide for an "integrated and coordinated disaster management approach" that focuses on "preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery", and to provide for "declarations of national, regional and local disasters". It provides for the establishment of the "National Disaster Management Risk Fund", and related matters (GRN, 2012d).

5.11 Land use planning

According to the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the increase in conflicts over land, the adaptation of land to climate change and the increase in income and power gaps, have significantly changed the role of land use planning. Land use planning is now essential for any spatial development and aims for social, ecological and social sustainability (GIZ, 2011:13) Land use planning entails principles of planning, as well as the principles of law, and is the "systematic assessment of land and water potential and alternatives for land use and economic and social conditions in order to select and adopt the best land use economic and social conditions in order to select and adopt the best land-use options". The Namibian land use planning legislative and policy framework was adopted from the planning that prevailed in South Africa during the administration of South West Africa, as Namibia was known prior to independence. Therefore, since Namibia's Independence, the country faces the challenge of correcting the injustices in the land use planning system and to develop a sound sustainable land use planning system. There are numerous different national policies, as well as the Vision 2030 and National Development Goals that advise the country with regard to the land use planning framework (!Owoses-/Goagoses, 2016: 191-192), but Namibia lacks a National Land Use Planning Policy that will integrate land use planning (Jones, 2009: 3). The administration of land use planning in Namibia takes place at national, regional and local government levels (!Owoses-/Goagoses, 2016: 201).

5.10.1 Land use planning in local government

At local government level, town planning is considered as land use planning, concerned with the control and regulation of land in a local authority and involves the zoning of land, as well as the establishment of townships (!Owoses-/Goagoses, 2016: 204). The

City of Windhoek's Town Planning scheme dates back to the apartheid years and includes more recent amendments up to 2014. It is thus now referred to as the Windhoek Town Planning Amendment Scheme no. 90. The Town Planning Scheme specifies different land reservations for the use of specific purposes that it is reserved for, and only Council can consent to the erection of building on reserved land. Chapter V and clause 26 of the Town Planning scheme indicate that no buildings should be erected on land, of which for any reason, may endanger or cause injury to health. The pollution of groundwater or alteration of physical, chemical or biological properties of groundwater is prohibited, and it directs that the dumping of refuse, rubble and other hazardous substance should only be done on sites designated by council. Moreover, the sinking of boreholes, or wells, are prohibited. The stripping of topsoil and the mining, or removal of sand or graves, from any watercourse is also not allowed. Water infiltration areas are protected and any construction on 1 in 50-year flood lines is prohibited (City of Windhoek, 2014: 23-26). The Windhoek Town Planning Scheme thus indirectly makes provision for sustainable development by the conservation of its natural resources through the protection of groundwater, infiltration areas and soil. Also, since activities that may endanger life, or cause danger to health, are prohibited – it can be said that the life of the entire biodiversity matters and should be protected from danger because the scheme does not specifically mention the lives of humans only.

5.10.2 The Windhoek Structure Plan of 1996

The Windhoek Structure Plan of 1996 indicates that strong policies should be formulated in the City of Windhoek. It highlights that public transportation will need a good road network, and that the road network be reviewed and revised to put the goals of the Windhoek structure plan in effect. With regard to housing, higher density housing, such as flats and townhouses, is advised. A resident survey showed that migrants, with less education and low skill levels, would be willing to accept un-serviced, or partially serviced, sites on which they can at minimum erect shacks. The Structure Plan also refers to activities in Windhoek that can be followed to create a more sustainable City, including environmentally sensitive areas that must be protected and specifically the narrow valleys, hill tops, major water courses and dams, as well as the rural periphery which is referred to as the Green belt of mountainous areas surrounding Windhoek (City of Windhoek, 1996).

The City of Windhoek compiled the Windhoek Environmental Structure Plan (WESP) later in 2004, to specifically manage environmental degradation and guide land use planning in Windhoek (City of Windhoek, 2004: 8). The WESP will now be discussed.

5.10.3 Windhoek Environmental Structure Plan and Policy of 2004

The approach of the WESP is based on the environmental clauses, Article 95 (l) and 91 (c), of the Namibian Constitution, which sets a basis for environmental protection and management in Namibia. It is therefore essential for local authorities to have a policy to effectively implement town and regional planning in a sustainable manner and in accordance with Article 95 (l) of the Namibian Constitution. The development of the WESP was done with extensive public participation and the following environmental aspects were considered: water management, protected areas and open space management, the management of the natural environment, air quality, waste and sewage management and the management of cultural and historical resources, as well as development aspects such as land uses that pose a risk to water resources and flood plain areas, land uses that pose a risk to vegetation cover, land uses that pose a risk to the aesthetical beauty of Windhoek, land uses that pose air pollution risks and land uses that are likely to cause a nuisance. Thus, the environmental structure plan developed sensitivity zones according to these risks, to ensure environmental protection and "an improved environment" with "better environmental performance" coupled with improved "socio-economic sustainability" (City of Windhoek, 2004: 9-15). The Windhoek Environmental Structure Plan and Policy document was followed by the State of the Environment Report (SOER) in 2008.

5.10.4 State of the Environment Report (SOER) of 2008

Namibia's Ministry of Environment and Tourism (MET), through the directorate of Environmental Affairs (DEA), steered a programme on sustainable development in Namibia called "Information and Communication Service for Sustainable Development" in Namibia. The programme was financed by the Government of Finland and was divided into sector specific areas with the aim of providing up to date information for policy makers, technicians and the public on health and trends in

Namibia's environment, as well as key indicators for long term monitoring of the environment and the performance of environmental policies (GRN, 1998b; 1-2).

The City of Windhoek conducted its own SOER in 2008. It included a baseline study on the State of the Environment and the Key Sustainable Environmental Performance Indicators for Windhoek. The resources selected as the core indicators to measure sustainability in Windhoek were bio-physical resources, infrastructure and services, and the socio-economic conditions. Thus, the aim of the SOER was to provide credible environmental information for measuring the progress of sustainability in Windhoek (City of Windhoek, 2008b: 1-5).

Some of the findings in the report were that the water demand would exceed the water supply by the year 2015. Moreover, there were some threats to the biodiversity habitats from impacts such as encroaching, littering, dumping, pollution, topsoil stripping and the use of the open spaces as toilets. Most residents were supplied with water, sewerage, electricity, road and storm water systems; however, low income areas only had communal services and gravel roads, while the informal areas lack sanitation and water. Also, the high influx of poor people was placing pressure on the natural resource base due to deforestation, air pollution, excessive fossil fuel consumption and poor sanitation. Thus, it was found that the City was not able to keep pace with the provision of fundamental services to poor migrants. Moreover, there was a lack of environmental training among staff members and the environmental performance was not yet part of the municipal culture. In addition, the capital expenditure allocated for environmental sustainability did not increase at the same rate as the overall capital expenditure in the City of Windhoek (City of Windhoek, 2008b: 82-83). In 2009, the City of Windhoek conducted a Biodiversity Inventory Report that will now be discussed.

5.10.5 Windhoek Biodiversity Inventory Report of 2009

The Ministry of Environment and Tourism in Namibia developed the first "National Biodiversity Strategy and Action Plan for Sustainable Development through Biodiversity Conservation" in 2001 and it spanned the years 2001-2010. The aim of this action plan was to "protect ecosystems, biological diversity and ecological processes" through biodiversity conservation and promoting sustainable use of natural

resources. Thereafter, Namibia's second National Biodiversity Strategy and action Plan (NBSAP2) was developed to span the years 2011-2020 (Hinz & Ruppel, 2016:153-154). The City of Windhoek steered its own biodiversity inventory report after Namibia's first National Biodiversity Strategy. This local report had similar goals, but was restricted to the area of the City of Windhoek.

The Windhoek Biodiversity Inventory Report was intended to assess the state of its biodiversity, and to advise on methods for restoring and preserving biodiversity and important habitats. Various policy recommendations were proposed for implementation by the City of Windhoek, summarised as follows:

- The protection of habitats and indigenous vegetation in the Brakwater area that was proposed as an industrial area (it was requested that the proposal be reconsidered),
- Rezoning and sale of riverbeds for development not be allowed,
- Reconsidering the storm water regulations to include biodiversity and ecological principles,
- The banned list of invasive species in the town planning scheme be updated to include all alien invasive plant species and in addition, a clause to be included for the preservation of protected tree species,
- The health regulations to be updated to prevent alien plants from being sold in retail nurseries and to prohibit the feeding and support of feral cats,
- The lease agreements of commonage farms to be revised to include environmental aspects, and
- A standard term of reference be developed for conducting Environmental impact assessments in the City of Windhoek (City of Windhoek, 2009).

Unfortunately, there is no evidence that the recommendations of the report were implemented by the City of Windhoek.

5.10.6 The 2011 Strategic Environmental Assessment: Windhoek and Windhoek Townlands

The City of Windhoek undertook the Strategic Environmental Assessment (SEA) to conform to the requirement of the Ministry of Environment and Tourism and Part X of the General Provisions, Section 56 of the EMA. The aim was also to provide input and

guidance into the future spatial development and planning for the City of Windhoek. It was stipulated that the findings of the SEA were in support of the information contained in the WESP of 2004 with regard to the land best suitable for future development in Windhoek. The SEA confirmed that the development potential for areas south and south-east of Windhoek was limited due to the Windhoek Aquifer that was contained in this area. This area was subsequently classified as a Very High Environmental Control Zone. The SEA also identified two types of cumulative impacts, namely, the overarching cumulative impacts affecting the city as a whole, and site-related cumulative impacts that were associated with site specific impacts.

The overarching cumulative impacts included the increased pressure on the scarce resources, such as water and land, due to urbanisation, unemployment and poverty, pressure on existing infrastructure and services, growth of informal settlements and the degradation of the natural environment.

Site-specific cumulative impacts were that current proposed developments were already contradicting the WESP and falling in Very High Environmental Control Zones – some within the aquifer management area, thus the water sensitivity zone.
Moreover, the SEA also identified land use challenges that the City of Windhoek was experiencing namely, the provision of housing and basic services, the development of industrial areas, the identification of sites for new cemeteries that would not fall within the water sensitivity zones, the identification of new landfill sites, taking into account the potential pollution of ground water, and finally, the protection and management of natural resources that contribute to the City of Windhoek's "sense of place" (City of Windhoek, 2011).

It appears that the WESP and SOER for the City of Windhoek played an important supporting role in the study of the SEA of Windhoek as reference was made numerous times to these reports. In addition, the City of Windhoek has other policies and plans relevant to sustainability and resilience, namely, public open spaces, transportation, disaster management and more recently the drought response plan. The City also recently compiled a new five-year business plan for implementation.

5.12 Policies and plans in the City of Windhoek

The policies and plans relevant to sustainable development and resilience are briefly outlined.

5.12.1 Policy for the distribution and future usage of public open spaces in Windhoek

This policy was developed and came into effect in 2001. Its aim was to guide the future use of public open spaces in Windhoek, and encourage the conservation of biodiversity in natural parks around the periphery of Windhoek. The policy also specified that the riverine systems of Windhoek needed special protection and buffer zones should be extended next to the rivers to help with seepage of water into the ground water reserves. In addition, the policy emphasises that adequate provision of open space should be made within a reasonable distance from all residences: a guideline of 800-1000-meter radius from any household was given, to serve as a playground or suburban park where residents can enjoy leisure time. Moreover, open spaces for walking trails, bicycle routes and viewpoints were identified, as well as recreational opportunities around the Goreangab, Avis and the smaller Van Rhijn Dam. Additionally, the commonage farms that were situated around the Green Belt of Windhoek were identified as possible opportunities for sustainable economic development and to conserve the natural heritage (City of Windhoek, 2001).

The problems experienced in the public open spaces at that time included the following: pollution, erosion and deforestation, abuse of alcohol and illegal substances, illegal encroaching and squatting. The policy encouraged community participation and emphasised that community facilities should not be privatised and not be sold. Therefore, the policy indicated that the City of Windhoek realised that the establishment of common goals in the conservation and utilisation of open spaces in the City is essential for social upliftment and improving the living conditions of the residents in Windhoek (City of Windhoek, 2001).

In 2011, a community based organisation, the RiverWalk Initiative, was established to uplift and rehabilitate the rivers in Windhoek. The initiative's objective is to revive existing rivers and adjacent green areas in Windhoek which are inaccessible to the

public. These open spaces can form future pedestrian and cycling routes, or be used as walking paths for parents and children, joggers, dog walkers, as well as tourists. The River Walk Initiative will benefit the City immensely, apart from the 3000 households that are situated along the proposed route. The City of Windhoek agreed that the RiverWalk Initiative is likely to reduce crime in the riverbeds (The Namibian, 2015). To date, the City of Windhoek has not yet made funds available for the implementation of the RiverWalk Initiative.

5.12.2 City of Windhoek's Transformational Strategic Plan 2017-2022

The Transformational Strategic Plan complements Namibia's development goals of Vision 2030, the Harambee Prosperity Plan and NDP 5 (City of Windhoek, 2017d: 11). It outlines different objectives with Key Performance Areas (KPAs) for implementation. One of the KPAs is Land-use Management, with a review of the Windhoek Town Planning Scheme, existing development area policies (and proposed new policy areas), and the Central Business District area with its surrounding areas (City of Windhoek, 2017d: 47).

The City is planning to reduce its reliance on NamPower for generated electricity by investing in a renewable energy plant to generate electricity, and by permitting consumers to generate their own electricity through small-scale, embedded generation of electricity (City of Windhoek, 2017d: 48-49).

Another KPA is pursuing alternative water supplies to the City. Investigations are underway to obtain an alternative water supply from the Okavango River some 800km from Windhoek and desalinated water from the Central coast about 350km away. The City itself aims to maximise re-use of water and to minimise losses by establishing a direct potable re-use facility at the Gammams water reclamation plant site, to reclaim treated water for potable consumption and by minimising technical and non-technical losses (City of Windhoek, 2017d: 49-50).

The City also aims to develop the youth, orphans and vulnerable persons to improve leadership skills and promote pro-social values for these community members to make

valuable contributions at school and in their respective communities (City of Windhoek, 2017d: 52).

5.12.3 The 2013 Sustainable Urban Transport Master Plan (SUTMP): Move Windhoek

The City wishes to ensure that it has an efficient and integrated transportation system to create a quality urban environment, support economic growth and social inclusion, improve resilience and resource efficiency and to position Windhoek as a global leader in implementing pioneering solutions to transport challenges such as congestion (City of Windhoek, 2017d: 50).

The Sustainable Urban Transport Master Plan (SUTMP) Move Windhoek (City of Windhoek, 2017d: 47-52) supports the priorities in the NDP 4 for "Faster and sustainable economic growth, creation of employment opportunities and enhance income equality" The SUTMP also supports Vision 2030 which is part of the goal to improve GDP growth and employment. It was developed by using best practices and lessons learnt worldwide and includes experiences in other African cities and cities in Europe, South America and Asia (City of Windhoek, 2013: 15-22).

The taxi industry forms the backbone of public transportation in Windhoek; however, taxi's are involved in the majority of daily accidents in the CBD. The non-motorised transport is the second most popular means of transport in Windhoek, but the northern and central areas of Windhoek lack proper infrastructure to accommodate pedestrians and cyclists.

Figure 5.1 illustrates the current problems experienced in the public transportation sector with residents waiting for public transport after work at a bus stop in Nelson Mandela Avenue in Windhoek. The crowding of people at the bus stop and further up the road is due to the shortage of taxis. Also, note the taxi stopping in the middle of the road to pick up customers.

Figure 5.1: A picture of residents waiting on public transport in Windhoek and a taxi stopping in the middle of the road to pick up customers

The implementation of the SUTMP will improve economic growth and secure direct and indirect employment creation. Moreover, traffic safety will improve, as well as the quality of service of non-motorised transport (City of Windhoek, 2013b, 11).

The strategy also aims to implement an advanced and integrated public transportation system, by creating a high-level bus service with a central bus station, supported by a rapid bus system and later a commuter rail transit system that will make use of the existing rail infrastructure. Integrated feeder services with minibuses and taxi's will be introduced and the system will be operational seven days a week. The new transportation system is intended to service all areas in Windhoek, including townships near Windhoek such as Finkenstein, Hosea Kutako International airport, Groot Aub, Omeya, Aris and Kappsfarm (City of Windhoek, 2013: 17).

5.12.4 Drought Response Plan of 2015

Drought severity indicators will determine the appropriate drought response programme. Primary indicator for the drought severity index is the available water in the dams supplying water to the central areas, and the availability of water in reservoirs. The Drought Response Plan consists of indicators and associated actions. There are four primary stages, and with each stage a more stringent response is recommended. The responses are:

- Water scarcity - increased communication on dry conditions;
- Drought - compulsory water restrictions;
- Severe drought - prohibit lawn watering; and,
- Water crisis - ration water for essential uses only.

In addition, during times of drought, the City of Windhoek will put into effect the following:

- Increase the supply of water by increasing production from the aquifer and by improving the water supply from the Goreangab Reclamation plant;
- Reduce water demand;
- Apply water scarcity;
- Implement water –use education and enforcement programme of the City
- Apply water restrictions as set out in the plan;
- Intensely monitor and evaluate precipitation, reservoir levels and water usage;
- Enforce restriction on the use of semi-purified water and restrict the use of water from water sources not owned by the City of Windhoek (City of Windhoek, 2015: 3-12).

5.12.5 Disaster Risk Management Policy of 2002

The Disaster Management Plan for the City of Windhoek was issued in accordance with the provisions of the Civil Defense Ordinance of 1979 and is based on four phases, namely, mitigation, preparedness, response and recovery.

The City aims to be in line with the requirements of professional Emergency and Disaster Management and international best practice. In co-operation and co-ordination with other public and private agencies, it will seek to preserve life and minimise damage to property and the environment from the effects of natural or unnatural emergencies or disasters.

Some of the natural hazards that are assumed are floods, fires, high winds, storms, earthquakes and severe cold or heat that could result in the destruction of life and property and the disruption of essential services. Moreover, droughts can destroy plant and animal life and cause water shortages for residents.

The technological hazards assumed are fire, industrial and transportation accidents, hazardous spills, dam failures, purposeful acts of terrorism, civil disorder, explosions, fuel shortages and failure of information systems. Moreover, hazards such as climate change, ozone depletion and environmental pollution are also noted. During emergency situations, the City of Windhoek will co-ordinate with the private sector such as churches, volunteer organisations and businesses to provide relief and human services to disaster victims. If it so happens that the emergency exceeds the capacity of the City of Windhoek, a disaster may be declared, and the City will then approach the Government's Emergency Management Unit for further action (City of Windhoek, 2002).

5.13 Summary

After Namibia's Independence in 1990, a new Constitution was implemented, and various policies, plans and legislation followed. The Namibian Constitution of 1994 supports environmental protection and sustainable development. Moreover, the policies included the Environmental Management Act 7 of 2007, which supports Agenda 21 and includes sustainability principles. However, after 28 years of Independence, Namibia is still battling with poverty, inequality and unemployment. In Windhoek, various problems have been created by urbanisation. Moreover, the City is finding it difficult to keep up with the influx of poorer people and providing housing and basic infrastructure such as fresh water and sanitation. This lack of basic services is placing a strain on the surrounding environment due to deforestation and pollution. Also, the City of Windhoek cannot keep up with the provision of serviced land for development. In turn, the City of Windhoek Structure Plan of 1996 cautioned against vast urbanisation and predicted the shortage of developable land. Still, the City of Windhoek was not able to prepare itself to be more resilient to the foreseen changes.

Although sustainability is mentioned in numerous policy documents and reports of the City of Windhoek, change is not visible. It appears that the monitoring and evaluation in policy implementation is not there. It can therefore be said that the institutional framework in the City of Windhoek for environmental protection and sustainability is in place, but effective implementation is lacking. The water shortages were already

predicted in the past. However, the limited rain received during the previous two rain seasons, compelled the City of Windhoek to develop and implement a Drought Response Plan in 1995.

Policies and plans to enhance resilience are still lacking in Namibia and the City of Windhoek. The NDP 5 indicated that resilience should be enhanced, but this needs more consideration in other plans for Namibia and the local authorities as well.

CHAPTER 6: DISCUSSION

This chapter discusses the research questions in the sections that follow. The research questions for the study are:

i. What are the current challenges that are hampering sustainability in Windhoek?
ii. Are the current policies and plans sufficient to address the sustainability challenges in Windhoek, and to build urban resilience?
iii. What mechanisms are required to address the sustainability challenges in Windhoek and to build urban resilience?

6.1 Current environmental challenges hampering sustainability in Windhoek

This section addresses the first research question and discusses the current challenges hampering sustainability in Windhoek.

6.1.1 Key social indicators

All the new sustainable development goals that expand much greater than the MDGs are applicable to Namibia, and more particularly SDG 1 on poverty and SDG 10 on inequality (Ruppel, 2016d: 392).

Although Namibia has managed to improve greatly in the provision of basic social services while maintaining a relatively stable economic and peaceful political environment, problems with regard to key social indicators still inhibit the country's ability to achieve all the goals set in Namibia's Vision 2030. The reasons for the slow progress are said to be the lack of proper execution, an absence of accountability, and efforts and resources that are spread too thinly (GRN, 2013a).

6.1.2 Climate change

Climate change is considered to contribute towards poverty (Gandure, 2013). Article 144 in the Namibian Constitution is regarded to be a constitutional link to international environmental law. The Namibian Constitution requires that policies adopted must ensure that all resources will be used "on a sustainable basis for the benefit of all

Namibians, and through this Namibia is obliged to protect its environment and to promote sustainable use of its natural resources" (Ruppel, 2016a: 30-31). Namibia's Climate Change Policy is based on this principle foundation. The climate change policy was officially launched in 2011 and the goal of the National Policy on Climate change is to contribute towards attaining Namibia's Vision 2030 through the strengthening of National capacities to reduce climate change risks and build resilience against climate change shocks. The policy is disparaged for being in conflict with existing sectoral policy instruments and even national sectoral development aspirations (Ruppel, 2016c: 364).

6.1.3 Urbanisation

Economic growth in Windhoek may negatively affect the environment, where it's coupled with urbanisation, resulting in the municipality of Windhoek not being able to keep up with the provision of serviced land for the in-migrants to construct proper shelters. Moreover, it appears that Windhoek has reached its capacity and the basin with land suitable for development has all been utilised. Development is now moving into the more uneven, hilly and mountainous areas of Windhoek, which are mostly conservation areas due to their biodiversity, and ecosystem services provided to the City. The underground water sources are also found in the southern Auas mountains which serve as the catchment area for water. The water demand in Windhoek has also increased due to the urbanisation and new sources of water need to be found in order to keep up with this demand.

6.1.4 Human Settlements

Many people in Windhoek still live in poverty, although poverty eradication is high on the agenda in the National Development Plans. In 2001, 30-40% of residents in Windhoek lived in informal settlements and the population growth rate in informal settlements is estimated at 9.5% per year (Ishimael, 2016: 2-25). It was also estimated that by 2016, 50% of Windhoek's residents would live in informal settlements (City of Windhoek, 2011: 13-14).

Moreover, Du Plessis & Landman (2002) identify three determinants for sustainability in human settlements, namely, "the quality of life offered to each citizen, the interaction

between the settlement and its biophysical environment and whether this interaction will continue to support an adequate quality of life, and the institutional ability to create and manage settlements that will continue providing an adequate quality of life within local and global environmental constraints".

The quality of life in the informal settlements is characterised by the poverty that prevails, absent or inadequate sanitation facilities, shortage of clean water and the absence of electricity (Ishimael, 2016: 2-25).

Crime is also an issue, further fueled by alcohol abuse, where numerous shebeens that operate in these areas make it easy for the people to obtain alcohol. In addition, the residents in the informal settlements live in corrugated iron shacks, or improvised shacks, mostly one room facilities that have to house families with a mother, father and children (Figure 6.1).

Figure 6.1: Informal settlement in Otjomuise, Windhoek

Since shacks are built anywhere where there is open land, and this makes them more vulnerable during floods and other natural disasters. Roofs can be blown off by wind

or the shack completely destroyed, and water from rainfall can flood the shacks, while heavy rains can erode the soil underneath the shacks, causing them to collapse.

In general, the shacks are very hot in summer, and they can be destroyed due to fires that start with candles used on the inside, leading to deaths and loss of property. In-migration will lead to an increase in the number of people living in shacks.

Residents in the informal settlements place pressure on the City's natural resources. They depend on the surrounding natural environment for their energy needs, cutting down indigenous trees for firewood, and using bushes and riverbeds as toilets.

6.1.5 Transportation

Transportation is a big challenge for Windhoek, with traffic congestion a major concern. The roads can no longer handle the number of cars during peak traffic. Non-motorised transport is unpopular in Windhoek, as the infrastructure to accommodate it is almost non-existent.

6.1.6 Water

The availability of water is of great concern. Firstly, the influx of people into Windhoek is not likely to decrease or stop because there are many attractions in the capital city such as opportunities for work and economic development. According to Martos *et al*. (2016: 485), for sustainable growth in cities, new systems of water production, purification, distribution and re-utilisations must be able to solve problems arising from quality and quantity of water, environmental protection, reduction of energy and the cost of water.

6.2 Current policies and plans for addressing the sustainability challenges in Windhoek, and to build resilience

This section deliberates whether the current policies and plans are sufficient to address the sustainability challenges in Windhoek, and to build urban resilience.

6.2.1 Policies and plans for sustainability

Since independence in 1990, Namibia has put in place a range of environmental legislations, policies and plans for environmental protection and to ensure sustainable development. The relevant national environmental instruments described in Chapter 5 were:

i. Namibian Constitution of 1990
ii. Namibia's Vision 2030
iii. NDPs
iv. Namibia's Green Plan of 1992
v. Harambee Prosperity Plan (HPP)
vi. Environmental Management Act 7 of 2007 ("EMA")
vii. The National Policy on Climate Change for Namibia of 2011
viii. National Climate Change Strategy and Action Plan of Namibia 2013-2020
ix. The National Disaster Risk Management Policy of 2009

Local land use planning instruments for the City of Windhoek include

i. Windhoek Town Planning Scheme
ii. Windhoek Structure Plan of 1996
iii. Windhoek Environmental Structure Plan and Policy of 2004
iv. The Windhoek Biodiversity Inventory Report of 2009

In addition to these, there is The Ombudsman, who is responsible to "protect and maintain the respect of the State for the rights of the individual citizen, to promote the rule of law, and to promote and advance democracy and governance". The Ombudsman investigates complaints regarding fundamental rights and freedoms pertaining to all branches of government including an environmental mandate to investigate over-utilisation of natural resources, ecosystem protection and maintenance, beauty and character of Namibia (Ruppel-Schlichting, 2016: 509-514).

However, these do not, *per se*, enhance resilience – both at national scale and for the City of Windhoek. Klaus Töpfer, the Director of the UNEP, stated that "*sustainable development cannot be achieved unless laws governing society, the economy, and our relationship with the Earth connect with our deepest values and are put into practice*

internationally and domestically" and "such laws must be enforced and complied with by all of society, and all of society must share this obligation" (Ruppel, 2016d: 390).

6.2.2 Policies and plans for building resilience

The national instruments for building resilience are:

i. The Namibian Constitution of 1990
ii. National Policy on Climate Change for Namibia of 2011
iii. National Climate Change Strategy and Action Plan of Namibia 2013-2020
iv. Disaster Risk Management Act, 2012 (Act No. 10 of 2012)

Local instruments for building resilience are:

i. Drought Response Plan of 2015
ii. Disaster Risk Management Plan of 2002

6.3 Mechanisms required to address sustainability challenges in Windhoek, and to build urban resilience

This section deliberates on what mechanisms are required to address the sustainability challenges in Windhoek and to build urban resilience.

6.3.1 Policy and legal framework

Chapter 5 indicated that after Namibia's Independence in 1990 a new Constitution that supports environmental protection and sustainable development, together with policies and legislation to promote sustainability were put in place. However, Chapter 4 identified numerous sustainability challenges. It can thus be said that after 28 years it is still battling with poverty, inequality and unemployment. Also, Section 4.6.1 indicated that in Windhoek, various problems have been created by urbanisation, and the lack of basic services is placing a strain on the surrounding environment due to deforestation and pollution. Chapter 5 indicated that policies and plans to enhance resilience are in place in Namibia and the City of Windhoek, such as the Drought Response Plan. Within the policy and legal framework, though, it appears that there is no monitoring and evaluation of policy implementation where indicators are reported on, which means that though the institutional framework in the City of Windhoek for

environmental protection and sustainability is in place, effective implementation could be lacking.

With regard to building of resilience, the municipality's Disaster Risk Management Division is responsible for "implementing disaster risk reduction activities aimed at building the resilience of communities within the municipal jurisdiction" (City of Windhoek, 2018). This Division initiated an initiative in 2004 and it was scaled up in 2012, to "ensure that schools are better prepared for emergencies and/or disasters that may affect them at any given time" (City of Windhoek, 2018). It focusses on assisting schools to set up Emergency Preparedness Plans and raise awareness on Disaster Risk Management discipline, provision of basic training in the use of fire extinguishers, demarcation of assembly sites, designing of floor plans, carrying out emergency drills and conducting a quiz for participating schools. The initiative will continue until all schools within the jurisdiction of Windhoek Municipality have participated". By July 2018, 90% of schools in Windhoek had participated in this initiative (City of Windhoek, 2018).

Resilience must be considered together with sustainability to overcome the sustainability challenges in Windhoek. For cities to be prepared for environmental changes, they should first be acquainted with their dependence on the services that the surrounding environment and the ecosystem provide (World Bank, 2012: 17-18). Therefore, the City of Windhoek will need to clarify what is to be sustained in the city. Also, it should be able to identify the resilience "of what", as well as "to what". In the City of Windhoek, the disturbances are climate change, drought and the economic uncertainties. Therefore, the adaptation and mitigation strategies as explained in section 5.8 of the NCCSAP 2013-2020 should be implemented, monitored and evaluated.

As described by Uprichard & Byrne (2006: 665), cities are treated as complex systems. The City of Windhoek also shares the characteristics of a complex system as described by Bai, *et al.*, (2016: 71-72) in Section 2.3.4 and therefore a systems approach for sustainability and resilience should be implemented. Also, Section 2.3.4 indicates that systems can be designed and redesigned (Meadows, 2001: 59) which can be said to make the system flexible for change. The systems approach to sustainability and resilience could therefore guide the City of Windhoek in recognising that all the

characteristics of the open system need to be accounted for in the decision making processes.

6.3.2 Transversal co-operation

In order to enhance environmental performance, it is vital to promote co-operation across different urban sectors, and that integrated planning that combines land use and urban development with other policies be used in all sectors (UNEP, 2011: 480).

The EMA makes provision for the establishment of a Sustainable Development Advisory Council (SDAC) to advise the Minister of Environment and Tourism on issues related to sustainable development in Namibia (GRN, 2012b: 9) as indicated in Section 5.6. The SDAC has prioritised environmentally sustainable urban expansion, water resources management and drought and flood preparedness (SDAC, 2014b: 17-18). The latter is critical for sustainability and resilience challenges in the City of Windhoek.

Section 2.4.1 identified many definitions of resilience. According to Folke *et al*. (2002: 8) a general picture from the many definitions of resilience is one of "going with the flow" – "we can't change the future, we just have to "suck it up" and learn to live with it, to follow the changes and then re-organise as best we can. However, this is a very deterministic, mechanical view of the world where we are hostage to events over which we have no control. With such a mechanical approach, Government usually attempts to control, or channel, change through formal policies, legislation or administrative measures. The paradox is that such rigid control can stifle system learning and flexibility and erode resilience, whereas management of resilience-building must be flexible and open to learning (Folke, *et al.*, 2002: 8).

Perhaps the greatest challenge within urban systems is the issue of "surprise". Surprise is a discrepancy between what is observed and what is expected, and it creates unexpected demands. Lanir (1986) describes two forms of surprise, as follows:

i. **Situational surprise**. Compatible with previous beliefs, can be averted by foresight.

ii. **Foundational surprise**. Cannot be anticipated. It refutes basic beliefs about 'how things work'; one cannot define in advance the issues for which one must be alert; advance information actually causes the surprise.

A surprise will require a re-framing of the data and filling the gaps. "Governance will need to address both the role of social framing of system boundaries and risks, possible trade-offs and asymmetries in resilience between different groups and communities within the system" and considering the question. "resilience of what, and for whom?" (Duit, *et al.*, 2010: 365).

The City of Windhoek should therefore be "brave" and promote interaction and allow for flexible collaboration and open institutions that would allow for agility in dealing with surprise, learning and the building of adaptive capacity (Folke, *et al.*, 2002: 9), so that not only current needs of the communities can be addressed, but also those of future generations.

Policy networks are an effective instrument for accomplishing this.

6.3.2.1 Policy networks

Policy network theory is based on the notion of interdependency between different roleplayers, that no one can work in isolation, and sharing of information and resources. Its assumption "is that nobody is an expert in everything, and nobody has sufficient resources to address every problem" (Karemera, 2004: 3). The members of a network may have different interests, but share common values and collaborate to achieve certain policy objectives. The "bridges" to facilitate these interactions are communication and trust to foster interconnectedness to better address four critical factors across temporal and spatial scales during periods of change and reorganisation (Folke *et al.*, 2002: 18-20):

i. **Learning to live with change and uncertainty**. "Social-ecological systems accept uncertainty and change" (surprise), and take advantage of such change to turn it into "opportunities for development" when they are robust and adaptive.

ii. **Nurturing diversity for resilience**. Diversity provides "history and accumulated experience helps cope with change, and facilitates redevelopment and innovation following disturbance and crisis". Social and institutional learning can be deployed through policy networks to help absorb disturbances, spread risks, create novelty and avoid shifts to less valuable states.

iii. **Combining different types of knowledge for learning.** Various methods of "knowing and learning" allow diverse stakeholders actors to work collaboratively, even when faced "with uncertainty and limited information". Accumulated knowledge and experience provide a matrix for how to respond to change.

iv. **Creating opportunity for self-organisation towards social-ecological sustainability**. The learning process is central to building "capacity for social-ecological resilience". Flexible social networks that move through learning-by-doing adapt better than rigid social structures. It includes the use of "monitoring to generate and refine knowledge and understanding" for adaptive co-management.

6.3.3 Water demand management

Implementing the Water Demand Management and Drought Response plans only in times of limited rainfall are unlikely to solve the problem in the long term in Windhoek. As indicated in section 4.2.3.1 the Windhoek aquifer has been over-utilised during the past 50 years and is steadily declining (Van Rensburg, 2006: 29-31), therefore permanent alternative solutions need to be sought. Effective water management by means of comprehensive water management regulations should include water re-use, domestic water supply, industrial water usage, pollution of water channels, underground water and the main Windhoek aquifer. Moreover, the regulations should also contain the condition that only landscaping for dry weather conditions such as xeriscape gardens be established in Windhoek. Also, the regulations should include strategies to handle uncertainties and complexities that will strengthen the capacity to adapt to future water changes.

As indicated by Sharifi (2016: 633) the uncertainties in climate change prediction result in changes to adaptation thresholds and it is thus difficult to set long-term resilience goals. Therefore, the regulations should be implemented, monitored and re-evaluated

from time-to-time to establish the effectiveness in a multilevel governmental approach. Hence, as explained by Olazabal (2012: 38), to affect the transition in cities, they will need to develop their capacity to transform by means of learning and knowledge management as primary tools for resilience management.

In addition, not only should the responsibility of water conservation and management be an obligation for government and the local authority only, but the residents themselves should be made aware of local ecological conditions, that a water scarcity is imminent and therefore permanent water savings measures in every household should be implemented, that is, for individuals and communities to adapt and transform their water usage to be resilient against the water shortage. This awareness creation could form part of educating the communities. In turn, this would assist with the provision of a sustainable water supply in future. The water supply thus needs to be sustained for current and future generations, and for the ecosystem.

6.3.4 Heat islands

The heat of solar radiation along with the heat produced in cities from other causes can increase the temperature in certain urban areas. This is often referred to as heat islands. Green urban areas can contribute to minimising these effects under certain conditions (Martos *et al.*, 206: 484), and the City of Windhoek should therefore implement its Public Open Space policy of 2001 (discussed in section 5.12.1 of this study), decisively for public parks, both formal or informal. During the planning process for future suburbs, public open spaces and private open spaces should be included to ensure that all residents have access to open spaces for sport and recreational use. As indicated by Martos (2016: 484), urban parks and open green areas play an important role on the quality of life of an urbanised society. It promotes social integration and interaction among citizens, and green areas in cities can act as urban lungs by providing environmental and psychological benefits (Martos, 2016: 484). Also, with current erven for houses being small and sites of high-density developments, it is imperative that public and private open spaces form part of development to ensure that residents, and more specifically children, have places of recreation. As indicated in section 5.12.1, these public and private open spaces can serve as sport fields, public parks, swimming pools, community centres and other public amenities. Apart from minimising heat and

solar radiation and the effects of global warming and climate change, the provision of sport and recreational facilities will ensure social upliftment, improve the quality of life of the residents and add economic value to Windhoek.

6.3.5 Unemployment and poverty

From the discussion in section 4.4.1 of this study, it can be said that the City of Windhoek faces many concerns with unemployment and poverty, exacerbated by in-migration to Windhoek. Furthermore, the unemployment is coupled with low education levels. Hence, as discussed in section 2.2.2, one of the propositions made by Ness (1997: 17) to promote sustainability, is that of promoting and increasing human productivity, as a manner of improving the living standards of citizens. Also, according to Suzuki, *et al*. (2010: 95) education improves the prospects for economic development through a productive workforce. As elaborated in section 4.4.2, even though the Government built schools after independence in 1990, the lack of schools in lower income areas in Windhoek remains a problem due to the rapid urbanisation. Therefore, a strategy needs to be established to build schools closer to the poorer communities. Children should be able to walk to the nearest schools, because the transport costs for the parents of the children will be unaffordable as these poorer communities are already struggling just to provide food for their everyday survival.

Moreover, Garrard, *et al.* (2017: 11) indicate that there is evidence that many Namibians living in urban areas, more specifically the youth, are disconnected from the natural environment. Environmental education and specifically, sustainable development and resilience, need to be emphasised and introduced into higher learning as well. The University of Namibia (UNAM) and the Namibian University of Science and Technology (NUST) should introduce courses in higher learning that will promote sustainable development and resilience. According to Bolis, Morioka & Sznelwar (2017: 317) the societal goals are greater sustainability, and it would be effective to influence education to embrace values that are nearer to sustainability. Thus sustainability-related values should be introduced in education.

6.3.6 Human settlements

Section 4.6.1 also indicated that most residents residing in informal areas in Windhoek are historically disadvantaged, and these residents also deserve access to services, proper facilities and other opportunities that are available to the other residents of Windhoek. Davidson (2010: 875) indicates that in Vancouver, Canada, the city Metro Vancouver defines 3 major components of social sustainability, namely (1) Basic needs such as housing and sufficient income that must be met before capacity can develop, (2) individual or human capacity or opportunity for learning and self-development; and (3) social or community capacity for the development of community organisations, networks that foster interaction.

Social resilience in communities should be supported and should be aided to withstand the external shocks such as drought conditions in Namibia and Windhoek that result in water shortages. Therefore, community forums should also be used to build knowledge within the communities regarding sustainability, and the importance of the surrounding ecosystems.

6.3.7 Built environment

Urbanisation gives rise to the influx of people into the cities and this makes the built environment an important factor to consider in sustainability. According to Brody, Carrasco & Highfield (2006: 295) development outside the urban centres diminishes open space, fragments wildlife habitats and inhibits the functioning of the ecological system. Many households in Windhoek do not have access to basic sanitation, water and electricity. The residents in the informal settlements that live in corrugated steel shacks and improvised shacks make up most of these households (Figure 6.2).

The City of Windhoek should start with the provision of basic services such as electricity, water and sanitation to these households. The provision of electricity will lessen the negative impact on the environment that is caused by the cutting down of trees and unnecessary pollutants entering the atmosphere. The provision of water and sanitation will lessen diseases as clean water would prevent illnesses such as diarrhoea and the safe disposal of human waste would reduce diseases. The provision of housing should be prioritised to deliver safe and secure shelters that have basic services such as

water and electricity. Moreover, the policies should also aim to provide opportunities for learning for the individuals and further support community organisations, discussed in Section 4.6.1, such as the National Housing Action Group (NHAG) and its partner the Shack Dwellers Federation of Namibia (SDFN). By supporting these initiatives, the residents living in poverty would feel that their needs are being addressed.

Figure 6.2: Corrugated iron shacks and improvised shacks in the informal settlement, Otjomuise Windhoek

Additionally, policies should be put in place to promote the use of solar energy for electricity. Solar geysers should be preferred above the normal geyser that makes use of electricity only. Gas stoves should be endorsed to be used in especially new houses and business establishments such as in the hotel industry. The general design of green buildings that are more environmentally responsible and resource efficient should be promoted in the construction industry to promote sustainable development and in turn, resilience.

6.3.8 Transport and Infrastructure

Fundamental choices for sustainable urban development include the area's transport and infrastructure (Dassen, Kunseler & van Kessenich, 2013: 202). Promoting redistribution and investing in transport can increase economic growth (Fourie, 2008:

482). Also, transport planning has become an essential tool for remodelling cities (Martos, *et al*., 2016: 480).

Section 4.6.4 also indicated that many people in Windhoek cannot afford their own vehicles and are obliged to use public transportation, which is limited to bus services and taxis. The non-motorised transport (NMT) system is not efficient, as cycle lanes and sidewalks for pedestrians are not available throughout Windhoek.

Section 3.3.1 indicated that in Curitiba, the bus was selected as the main transportation mode. Moreover, high density residential buildings and mixed land use were assigned next to the transportation lines. Low-cost housing projects are also developed along the roads. The buses meet the traffic demand and there are three types of buses being the express, inter-district and the conventional ones. Also, bus fares are the same irrespective of the distance travelled, to be affordable to all and the cost of public transportation is about 10% of the resident income. By recreating the urban transportation system, some 85% of the residents make use of the bus services. Moreover, there has been a reduction in fuel consumption and air pollution, which in turn benefits the environment (Zhang, 2015: 431).

Also, when designing a sustainable urban transport system, one of the objectives should be to develop a multi-modal transport one that includes the use of bicycles. The use of electric vehicles should also be considered. The focus should be on shortening travel distances and minimising dependence on private motor vehicles (Martos *et al*., 2016: 480-481).

6.3.9 Waste management

The City of Windhoek has well-run and efficient landfill sites; however, these landfill sites have almost reached their capacity and estimated life span. New landfill sites need to be identified. According to Martos *et al.* (2016: 490) the multicriteria evaluation model of a geographic information system (GIS) can be used to determine new suitable landfill sites. Moreover, recycling programmes for glass, plastic, biomass and dangerous waste allow cities to respond to the challenge posed by the treatment of urban municipal solid waste and reduce the negative impact on the environment. Influencing

factors such as household income, house size and habits should be considered when designing policies (Martos *et al.*, 2016: 485).

According to Garrard, *et al.* (2017: 175) the first material recovery facility (MRF) was constructed by the Namibian business Rent-a-Drum in Windhoek, enabling the sorting of large volumes of mixed recyclables. Only a few suburbs in Windhoek are part of a recycling initiative. The City of Seattle (section 3.3.3) through its recycling initiative, has managed to save more than 3 million metric tons of greenhouse gas in the City and decrease the amount of refuse dispatched to landfill sites. Also, new requirements have been implemented for new construction, remodeling and demolition of activities in Seattle after the city realised that construction and development create a substantial amount of waste (City of Seattle, 2014: 9-10).

Therefore, by developing a recycling policy, all the residents will be required to take part in recycling of waste. In turn, recycling will prolong the lifespan of the current and new landfill sites and will therefore slow down the destruction of the environment in the long term.

6.3.10 Political environment

The political category involves conflict resolution by means of rules, institutional frameworks for regulating the economic, societal, and indirectly, the environmental aspects (O'Connor, 2006: 286). Moreover, the OECD Environmental Strategy for the First Decade of the 21st century highlights five fundamental objectives for environmental policies in the context of sustainable development, namely:

i. The maintenance of the integrity of ecosystems through the efficient management of natural resources;
ii. The de-coupling of environmental pressures from economic growth;
iii. Improving information for decision-making (measuring progress through the use of indicators);
iv. Enhancing quality of life by means of the social and environmental interface; and,
v. Improving governance and co-operation (Moldan *et al.*, 2012: 5-6).

Integrated environmental planning, such as in the Curitiba example described in section 3.3.1, where a combination of environmental policies, namely: “transportation, urban greening and recycling schemes with equity-based policies” such as health for the urban poor, has proven that poor cities in developing countries can be transformed to more “livable and affordable cities” (Basiago, 1999: 157). Also, the OECD recommends that to strengthen decision-making, governments should focus their internal policy design and implementation on integrating the three dimensions of sustainable development “by ensuring that key economic, environmental and social considerations are integrated into sectoral policy analysis, design and implementation”, prior to decision-making, by using tools such as environmental, social and regulatory impacts assessments (OECD, 2001: 20). The EMA of Namibia, discussed in section 5.6, refers to the EIA only as a tool to be used to ensure sustainable development.

In South Africa, Integrated Environmental Management is used as a tool to promote sustainable development. The DEAT (2004b: 8) defines Integrated Environmental Management as follows: “IEM provides a holistic framework that can be embraced by all sectors of society for the assessment and management of environmental impacts and aspects associated with an activity for each stage of the activity life cycle, taking into consideration a broad definition of environment and with the overall aim of promoting sustainable development”. Thus, such a tool framework could be beneficial for the Namibian government.

The principles of the IEM are based on a review and synthesis of various relevant principles for environmental policy and environmental assessment, and management worldwide. Adaptation, alternative options, community empowerment and continued improvement are some of the principles (DEAT, 2004b: 9). It can be said that these principles relate to resilience as well.

All sectors of society can make use of the IEM tools, i.e. “government /public sector, private sector and civil society, to inform decision-making that promotes sustainable development”. The tools include the following: “Screening, EIA, Stakeholder Engagement, Life Cycle Assessment, Environmental Auditing, Environmental Accounting, Technology Assessment, Cumulative Effects Assessment, Cost-Benefit Analysis, Environmental Economics, Ecological and Environmental Footprinting, Risk

Assessment, State of the Environment Reporting, Indicators, Sustainability Analysis, Strategic Environmental Assessment, Eco-labeling, Scenario Analysis, Sustainability Reporting, Environmental Management Systems, Environmental Policy and the Environmental Management Plan". Two fundamental trends of the IEM globally are the widened focus of IEM tools to address the triple bottom line emphasis of sustainable development and the development of tools that are now applicable to higher levels of decision-making outside the project level. (DEAT, 2004b: 10-14).

The Cities of Curitiba, Seattle and Bogotá, discussed in Section 3.3, have illustrated that the combination of land use planning, policies and public transportation to promote urban regeneration, preservation of the cultural heritage, as well as the preservation of the natural environment, were fundamental to the sustainability in these cities.

6.4 Summary

This chapter has addressed the three research questions of the study: The current environmental challenges hampering sustainability in Windhoek, the current policies and plans and their efficiency to address sustainability in the city and to build urban resilience, and the mechanisms required to address sustainability challenges in Windhoek and to build urban resilience.

Regarding the current environmental challenges hampering sustainability in Windhoek, the key social indicators showed that all the new sustainable development goals expand much more than the MDGs and are applicable to Namibia, in particular SDG1, on inequality. Moreover, Namibia's Climate Change Policy of 2011 was implemented with the objective of attaining Namibia's Vision 2030 through strengthening of national capacities and to reduce climate change risks, and to build resilience against shocks. This policy is, however, being criticised for being in conflict with the sectoral policy instruments. Urbanisation in Windhoek is a major challenge as it appears that the city has reached its capacity as the land suitable for development has all been utilised. This results in development moving into the more mountainous areas of Windhoek which are mostly conservation areas due to the existing biodiversity there. Moreover, many of the residents in Windhoek still live in poverty and reside in the informal settlements of

the city where there is a lack of basic services. These residents in the informal settlements put pressure on the surrounding natural environment as they depend on the natural environment for their energy needs such as firewood and the bushes and riverbeds are being used as toilets.

The current policies and plans identified to possibly build resilience is the Namibian Constitution of 1990, the National Policy on Climate Change for Namibia of 2011 and the National Disaster Risk Management policy of 2012, the Drought Response Plan of 2015 and the Disaster Risk Management Plan of 2002.

Regarding the mechanisms required to address sustainability challenges in Windhoek and to build urban resilience, it was conferred that there is no monitoring and evaluation of policy implementation in place and should subsequently be considered. Most importantly, resilience should be considered together with sustainability to overcome the sustainability challenges in Windhoek. Also, the systems approach to sustainability could be followed. Moreover, Transversal Cooperation to enhance environmental performance across different urban sections through policy networks are suggested to foster interconnectedness to address factors across temporal and spatial scales. The Government, as well as residents, should be responsible for water conservation and management. Regulations should be implemented, monitored and evaluated on a regular basis to establish the effectiveness. To curb heat island the City of Windhoek should put into effect the Public Open Space policy of 2001 to ensure more informal and formal public parks, as well as private and public open spaces that are managed sustainably. The unemployment and poverty in Windhoek should firstly be addressed by improving the education level of the people, due to the link that can be drawn between poverty and education. Also, because the majority of residents in Windhoek live in informal settlements, social resilience in these communities could be improved by creating community forums to build knowledge regarding sustainability and the importance of the surrounding ecosystem. The built environment should be improved through the provision of basic services to informal settlements and the public transportation system could be improved by putting the STMP in effect and promoting *NMT*. Furthermore, recycling in Windhoek should be improved as this could decrease the number of waste generated on refuse sites. Lastly, Integrated Environmental

Management should be used as a tool to promote sustainable development and resilience.

CHAPTER 7 - CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

At the beginning of this study the questions were posed: “Is Windhoek a resilient city that will be able to adapt to the unreliable environment and is the city developing sustainably to minimise further negative impacts on the environment that contribute to climate change?”

This was determined with three specific objectives, namely:

i) Identify and describe the environmental challenges for sustainable development in Windhoek. The key challenges identified and discussed in 6.1 were:

- Climate change
- Urbanisation
  - Human settlements
  - Transportation
  - Water

ii) Examine relevant policies and plans, and determine whether they are adequate for addressing sustainability challenges in Windhoek, as well as building urban resilience. As indicated in Chapter 5, Namibia already has legislation and policies at a national level for sustainability, as well as resilience in place. However, implementation isn’t tracked or monitored.

iii) Based on the literature and data gathered, make recommendations for addressing sustainability challenges and to build urban resilience. Recommendations were discussed in 6.3 for the following:

- Policy and legal framework
- Political environment
- Transversal co-operation
- Water demand management
- Heat islands
- Unemployment and poverty
- Human Settlements
- Built Environment
- Transport and Infrastructure

- Waste Management

Below are recommendations for enhancement of sustainability and resilience.

7.2 Recommendations for enhancing sustainability and resilience

Sustainability and resilience are of vital importance in the changing environment and an urgent integrated approach is necessary to effect changes towards a more sustainable and resilient Windhoek. The City of Windhoek should therefore devise an action plan for the short- to medium-term to promote the development of the city into a resilient and sustainable one. The action plan should be guided by Agenda 2030.

The 2030 Agenda for Sustainable Development aims at "transforming the world" – thus opportunities to enhance policies to promote sustainable development and building resilience in this era of climate change are presented. These new sustainable development goals are now interlinked, integrated, universal and transformative (UN, 2016).

These 17 new sustainable development goals (Fig. 7.1), that expand much more than the MDGs, are applicable to Namibia, with special relevance to poverty and inequality. As discussed in section 3.2 to achieve sustainability all three parts of the sustainability objectives, namely economic, environment and social, or "triple bottom line," need consideration together. Moreover, as indicated in 3.2.4, the political environment and built environment should be considered simultaneously because the political environment contains institutional arrangement to resolve conflict between the different goals of sustainable development. Also, the capacity and efficiency "of the urban built environment and techno-structures support human life and productive systems" without harming the biophysical environment.

Figure 7.1: Agenda 2030 Sustainable Development Goals (United Nations, n.d.).

Sustainability and resilience complement each other because sustainability is possible in a system that is highly resilient. Thus, resilience should be considered together with sustainability to overcome the sustainability challenges in Windhoek.

7.2.1 Resilience assessments

The City of Windhoek as a local authority responsible for initiating and formulating planning and development policies, initiating and promotion of employment creation, is accountable to the local inhabitants of the local authority and is responsible for the "promotion and creation of social well-being" of the inhabitants of the local authority. Therefore, the City of Windhoek has a duty toward its residents to make informed decisions that will protect the environment and promote economic development and social upliftment. As explained by O'Conner (2006: 286) in section 3.2 of this study, the "triple bottom line" ensures that economic activity must be "in the service of" the social activity and it infers that society's goals include environmental sustainability that hold the potential for the long-term sustainability of the economy, as well as society.

In addition, to develop resilience in communities, the adaptive cycle and panarchy models could be used to examine resilience in systems by studying the cross-scale interactions and thresholds, as explained in section 2.4.3 of this study. According to the Resilience Alliance (2010: 50) a Resilience Assessment should form part of the

planning process and is more effective when implemented with strategic plans and as part of the management processes.

The 100 Resilient Cities (100RC) Programme initiated by the Rockefeller Foundation, as described in section 2.4.7, has helped numerous cities worldwide to become more resilient to the physical, social, environmental and economic challenges affecting the 21st century. The programme focuses on shocks, as well as stresses that weaken the fabric of a city daily or occasionally. It would therefore be beneficial for the City of Windhoek to adopt the 100 Resilient Cities programme and subsequently implement the City Resilience Framework to align the goals of the city towards a more resilient one. The 100RC programme focusses on theory from complex- socio-ecological systems. From the research done on the City of Windhoek it can be said that the city is also a complex socio-ecological system similar to many cities in the world. Because adaptability and transformability are key in the complex adaptive system and apply to decision-making units, it is thus expected that sustainable development and resilience concepts be implemented during the policy, planning and project phases of development to ensure that the environment is considered, and that economic development does not come at a cost to the environment and the residents. Garrard *et al*. (2017, 165) state that "Namibian citizens have a responsibility to not sit back and let politicians and bureaucrats develop these frameworks alone". Public participation is vital to ensure that the government develops policies and laws that meet the needs of the citizens. To this end, policy networks should be encouraged and supported.

7.2.2 Sustainable water supply

In Windhoek, the main concern is that Namibia, being an arid country, the sustainable supply of water is a great concern. Integrated planning between the City of Windhoek planners and government, the public and private sector towards a common goal for sustainable development and resilience is necessary. The Green Plan for resilience and sustainability in Windhoek should therefore include objectives such as reducing the per capita water consumption by 30% within the next 18 months to enhance resilience for future drought spells.

7.2.3 Mitigating heat islands

The planning process should also include the planning of green infrastructure to curb excessive heat and solar radiation. The establishment of public parks, sport and recreational facilities would also promote inclusiveness and improve the quality of life for residents. The accessibility of residents to green areas within 1 km of every household should be promoted and a specific due date should be set for this goal: for example, that public open spaces and parks be developed within the reach of every household by 2025. The finances to implement this goal should also be identified. It is advised that the action plan should include goals such as planting 10 000 indigenous trees in the City of Windhoek within the next five years by 2023.

7.2.4 Inclusive green economy

The City of Windhoek should make an effort to increase the number of companies engaged in greening its operations. The action plan should identify methods to promote the establishment of the green companies. Tax incentives, such as less VAT payable by the companies, is a suggested method to motivate the establishment of these companies. The Action plan should suggest different criteria and indicators for the Green companies.

7.2.5 Improving education

As discussed in Chapter 4, unemployment and poverty can be linked to education. Improving the education standard of residents would enable them to obtain jobs with higher incomes. The shortage of schools should therefore be addressed. The objective of the action plan for the next 18 months should be to gather information on the number of schools in the City of Windhoek, the location of the schools from neighbourhoods to determine the accessibility of schools for learners, and also the number of children shown away annually due to classrooms being too full, should also be determined. Statistical information regarding the annual population increase due to urbanisation would assist with the estimation of the number of schools needed in future. This information should present an indication to Government of how to improve the primary and secondary education for children who grow up in Windhoek. Thereafter, once the primary and secondary school needs are determined, the need for tertiary education and the specific skills required can be determined.

7.2.6 Improving the built environment

In the built environment, section 4.6 and section 6.3.7 emphasised that one of the sustainability challenges in Windhoek is the housing standards of residents living in informal settlements. The residents stay in shacks made of steel plates or other improvised dwellings. Many residents of Windhoek live in informal settlements and the quality of life is not ideal. The City of Curitiba, as discussed in section 3.3.1, is well known for its state-of-the-art approach to urban growth, the combination of land use policies and public transportation to promote urban regeneration, preservation of the cultural heritage, as well as the preservation of the natural environment. Also, the City of Bogotá had similar challenges as the City of Windhoek and all this changed after the Mayor of Bogotá during 1998-2001 implemented an urban model that contributed to positively changing the attitudes of the residents of Bogotá. The City of Windhoek could adopt these strategies from other countries to improve the living standards for it people as well. National policies and capacities for effective planning and implementation should be developed that would define the benefits that citizens will derive from national wealth to improve the quality of life of the people.

The provision of adequate housing may not be possible in the near future due to the shortage of finances, and therefore the provision of basic infrastructure deserves a closer look in the short term. The provision of water, electricity and sanitation can improve the quality of life of the residents living in informal settlements and therefore the action plan for the City of Windhoek should look at identifying the number of households in the informal areas that lack these services. Thereafter, the action plan should also include a plan to provide basic services to households. Moreover, the action plan should make provision for the establishment of a committee consisting of councillors and staff members of the City of Windhoek, as well as officials of Government, who could have monthly meetings with existing and future community organisations from the informal settlements, in order to address problems more thoroughly and timeously. The meetings would present an opportunity for community members representing the informal communities to actively participate in dialogue with local government, as well as government, to find innovative solutions. An efficient feedback time should also be determined.

As discussed in section 3.3, the cities of Curitiba, Bogotá and Seattle, successfully implemented strategies for better public transportation and NMP, and this has attributed to improve the quality of life for the inhabitants of these cities. Therefore, the SUTMP of the City of Windhoek should be implemented as soon as possible and preference should be given to the development of NMT as this will be more affordable for many residents. Future planning should also include short routes of travel to curb the spending on transport and more importantly, to reduce air pollution. The action plan for the City of Windhoek should determine a realistic implementation plan for the SUTMP. Also, this plan should include the financial needs of each phase to allow for accurate budgeting. Most importantly, the plan should allow for regular feedback to stay abreast of the improvements and setbacks. The successful implementation of the SUTMP would enable residents to make more trips on foot, on bicycle and make use of the public bus service.

7.2.7 Integrated environmental planning and management

The City of Curitiba, as discussed in section 3.3.1, has a stable municipal governance and has years of uninterrupted city planning. Already in 1965, they established the Institute of Research and Urban Planning of Curitiba (IPPUC) which constantly monitors the city's planning process, and the policies in relation to the changing political and the economic environment. Thus, Integrated Environmental Planning is important to transforming the City of Windhoek and for addressing the sustainability challenges. Such as the case in Curitiba, it should be an ongoing process. Integrated Environmental Management provides tools to assess future development to ensure that it is sustainable. It is fundamental that the Action Plan for the City of Windhoek includes determining the environmental aspects that can negatively impact the economic, social and environment in the City. Thereafter, the environmental policy should be revised to better address the associated environmental impacts. As indicated in section 2.3.4, policies should be designed for adjustment to the changing system and these policies should contain feedback loops and meta-feedback loops to be able to alter, correct and expand loops when needed. The NCCSAP for 2013-2020, discussed in section 5.8, contains numerous adaptation and mitigation plans to adapt to the changing climate. This is crucial for building resilience in a city.

It can be advised that these processes be repeated on a five-year basis due to the changing environment. Based on the findings, the objectives, specific actions that need to be taken and the implementation thereof, should follow.

7.2.8 Summarised action plan for the city of Windhoek

The proposed action plan for the next 18 months for the City of Windhoek is summarised in Table 7.1 as follows:

Table 7.1: City of Windhoek proposed sustainability and resilience 18-month action plan

Biophysical Environment			
Aim	**Action**	**Indicator**	**Link to UN SD Goals**
Sustainable Water Supply	Integrated planning between Government, public and private sector.	Reduction in per capita water consumption by 30% Improved resilience of the water supply	Clean Water and Sanitation
Mitigating Heat Islands	Greener infrastructure in the City Planting more indigenous trees on City of Windhoek properties	Finances identified for the planting of at least 2500 indigenous trees per annum and for the development of more parks, sport and recreational facilities. Conserve large areas of usable public open space	Climate Action
Economic Environment			
Aim	**Action**	**Indicator**	**Link to UN SD Goals**
Inclusive Green Economy	Promote the establishment of green companies	Tax incentives introduced.	Decent Work and Economic Growth

		(Identify indicators and criteria for green companies)	
Social Environment			
Aim	**Action**	**Indicator**	**Link to UN SD Goals**
Improving Education	Collect statistical information on the needs for schools in Windhoek, the accessibility of schools. Collect statistical information regarding the annual population increase in Windhoek	Information available on the need for primary and secondary educational facilities. Information regarding the accessibility to schools available. Information regarding the annual population increase in Windhoek available.	Quality Education Eliminate poverty and inequality
Built Environment			
Aim	**Action**	**Indicator**	**Link to UN SD Goals**
Provision of Adequate Housing	Collect statistical information on the housing needs in Windhoek	Information available on housing needs to guide further action	Industry, Innovation and Infrastructure
Provision of Basic Services	Identify the households in need of basic services in the informal areas of Windhoek	Information available on needs for basic services to guide further action	Clean water and sanitation Affordable clean energy
Community/Municipality and Local Government Committee	Establishment of committee between residents, councilors and government to address needs in informal settlements	Improved social inclusion and active citizen participation	Partnerships for the goals

Implement the SUTMP	Identify areas for establishing NMT routes Include NMT routes in all new development areas Collection of statistical information on areas in need of bus services Collect statistical data on the number of people who walk or cycle to work Establish the number of buses needed to improve the bus services Collect statistical data on areas in need to taxi ranks. Invest in further research in order to implement the River Walk initiative.	Integrated land use of transportation systems included in all new development plans.	Industry Innovation and Infrastructure
Political Environment			
Aim	**Action**	**Indicator**	**Link to UN SD Goals**
Resilience Assessment	Adopt City Resilience Framework	Goals of the City aligned towards a more resilient City. The 7 qualities of resilient system visible.	Sustainable Cities and Communities. Sustainable Cities and Communities

Integrated Environmental Planning	Revise environmental policies \ Develop a recycling policy for the management of waste. Implement different Environmental management tools such as the SEA, EIA.	New innovative policies that are in line with the UN sustainability goals Reduction of waste in landfill sites. Improved communication of all parties involved including different specialists. Improved public participation. More informed decisions taken resulting in an improvement in environmental quality.	Peace, Justice and Strong Institutions Sustainable Cities and Communities. Climate action

The City of Windhoek can learn from the cities of Curitiba, Seattle and Bogotá with regard to planning sustainable development, policy reviews, resilience and programmes to address the sustainability challenges it faces.

The world today is far different from the one 20 years ago when the Rio Declaration was drafted in 1992. Many problems such as worsening climate change, loss of species and land degradation are experienced worldwide. The Millennium Development Goals have not been accomplished and consequently the far-off concerns from back then are becoming a reality (UNEP, 2011: 6). It can therefore be said that the system has changed and thus resilience should become a fundamental concept to enhance sustainable development. As cities can be said to be complex socio-ecological systems, adaptability and transformability should become essential concepts for resilience and sustainable development.

> "*the era of ecosystem management via incremental increases in efficiency is over. We are now in an era of transformation, in which ecosystem management must build and maintain ecological resilience*

as well as the social flexibility needed to cope, innovate, and adapt" (Holling, 2001).

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